technopolis group

April 2026

Strategic Priorities Fund (SPF) evaluation

Final Evaluation – Technical Annex

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Technopolis, in collaboration with Science-Metrix, Ipsos MORI and CECAN

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Appendix A Methodological aspects

Each phase of evaluation involved 5 main groups of data collection and analysis.

For the final evaluation, consultation activities (surveys and interviews) took place from March to July 2025. Bibliometric analysis was undertaken in July 2025 (based on a list of SPF grants from May 2025 and a list of publications reported to Researchfish by June 2025, but enhanced with a search of acknowledgements of SPF grants in bibliometric data[1]). Analysis of SPF outputs reported to Researchfish was undertaken in December 2025[2]. The final evaluation also included a review of the 33 programme evaluation reports (relating to 22 of the SPF programmes) that were available at the end of April 2025 (the cut-off point agreed to allow time for analysis).

The final evaluation report also draws on evidence obtained through previous phases of the evaluation. For example, key results from the process evaluation (undertaken in 2021) are presented. Similarly, selected results from surveys undertaken for the interim evaluation (in 2022) are presented, where this provides useful insight. Where such evidence is presented, it is clearly labelled with the relevant phase and year.

There were also two exercises undertaken for the interim evaluation that have not been repeated in the final phase. Instead, key results from the earlier analysis are presented within the current report:

- An analysis of UKRI (and SPF) spend in selected priority areas was undertaken in August 2022 (based on GtR data at that point). As the majority of expenditure had already been allocated by this point, the exercise was not repeated for the final evaluation.
- An analysis of application data (looking at the proportion of applications tagged to two or more fields of research) was undertaken for the interim evaluation, based on UKRI data provided in March 2023. As the majority of SPF proposals had already been made by this point, the exercise was not repeated for the final evaluation.

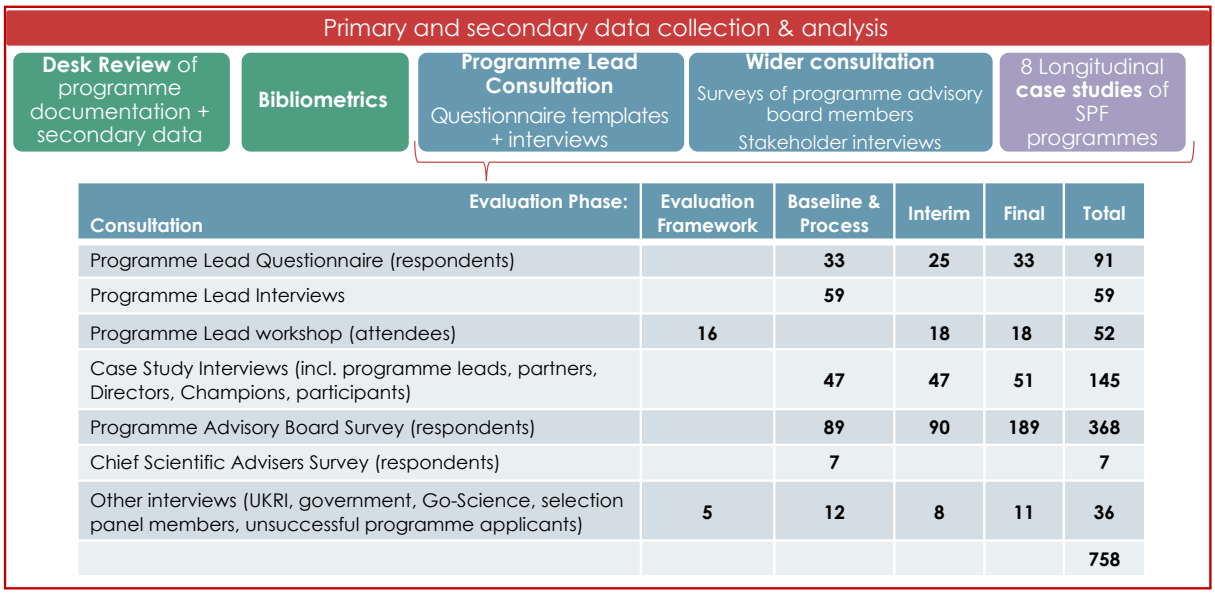
[1] Only papers published to the end of 2024 are included in analysis of multi- and interdisciplinarity, as this was the last full year of data available. Citation analysis is based on publications to the end of 2022, to account for lag (only around 30% of citations are accrued in the 2 years following the publication of a paper).

[2] The analysis had originally been undertaken based on outputs reported as of June 2025, however UKRI subsequently discovered that the database had not been fully updated with the previous year's reporting. The analysis was therefore re-run in December, based on the latest available data.

A.1. Consultations

Consultation activities have been a key part of the evidence collection process in each phase of the SPF evaluation. Over 280 stakeholders were consulted during the final evaluation phase via interviews and surveys, including SPF programme leads, co-leads, partners, participants and Advisory Board Members, plus representatives from government departments and agencies. Across all phases of the evaluation there were over 750 contributions from stakeholders via interviews, workshops and surveys.

Figure 1 Evaluation methods and consultation numbers



Consultation \ Evaluation Phase:	Evaluation Framework	Baseline & Process	Interim	Final	Total
Programme Lead Questionnaire (respondents)		33	25	33	91
Programme Lead Interviews		59			59
Programme Lead workshop (attendees)	16		18	18	52
Case Study Interviews (incl. programme leads, partners, Directors, Champions, participants)		47	47	51	145
Programme Advisory Board Survey (respondents)		89	90	189	368
Chief Scientific Advisers Survey (respondents)		7			7
Other interviews (UKRI, government, Go-Science, selection panel members, unsuccessful programme applicants)	5	12	8	11	36
					758

A.1.1. Programme lead consultation

We consulted with **programme leads** at each phase of the evaluation (Baseline and Interim Process, Interim Impact and Final) in different ways. This included:

1. Requests for basic information. Each phase, programme leads were asked to provide / update details of stakeholders involved in programme governance (leads and co-leads, government departments, Directors, Champions, Advisory Board members), both to support analysis of intersectoral involvement, and to serve as a database of potential consultees.

2. Programme lead questionnaire. A short survey was sent to all programme leads each phase to collect factual information on their programme and its implementation, as well as to ask for high-level views and perceptions on several key areas relating to Fund objectives. This asked, for instance, about the extent of involvement of different types of organisation in the implementation processes, as well as overall views on the added value of SPF. Subsequent interviews (see below) sought to build on these initial inputs and pursue areas in more depth.

3. Interviews. A selection of programme leads and co-leads were invited to participate in a semi-structured interview about their programme and experiences, as an input to the process evaluation (at the baseline phase), or as an input to case study development (in all phases).

4. Workshops. Workshops were held with programme leads during the baseline phase (to explore experiences of SPF processes) and interim phase (to explore activities around

supporting multi- and inter-disciplinary research and innovation, MIDRI[3]). Additional meetings were held with programme leads across all phases to introduce plans, update on progress or to present and collect feedback on findings.

A.1.2. Advisory Board Survey

The evaluation has run survey consultation exercises addressed to members of individual SPF Programme Advisory Groups (where these exist). The survey asked about their role and activities within the advisory group, their experiences of the SPF programme and views on added value in relation to SPF objectives.

A.1.3. Stakeholder interviews

Additional interviews have been undertaken with other stakeholders throughout the different phases of evaluation. For the case studies we have also consulted with other programme partners, government representatives, programme Directors and Champions and key participants involved in each of the programmes in focus. Others have also been interviewed at different stages, including representatives from government departments and agencies, selection panel members and unsuccessful programme applicants.

A.2. Measuring spend in government priority areas

Analysing UKRI spend in priority areas was undertaken in August 2022 for the interim evaluation. It required mining the entire Gateway to Research (GtR) database to compare investments made historically in the areas of interest (using a classification algorithm applied to grant abstracts). Given the scope of the exercise (and diversity of areas covered by SPF), we focused the analysis on the areas that correspond to the longitudinal case studies selected for the evaluation, which provide a good spread in terms of themes covered, partners involved and Waves. In order to draw comparisons with a benchmark (UKRI), the analysis focused on the value of grants in competitive calls. Not all SPF programmes had launched competitive calls (up to 2022) or planned to do so.

A total of eight priority areas were identified by the Government Office of Science together with departmental Chief Scientific Advisers (see first column of Table 1). Firstly, the analysis of SPF's coverage of these areas required the classification of individual SPF-funded grants. This was achieved by using TextRazor, a Natural Language Processing (NLP) service. TextRazor offers out of the box classification models based on publicly available taxonomies such as Wikipedia[4], DBPedia[5] and Wikidata[6]. Its classification service is based on a proprietary

[3] Multidisciplinary R&I involves different disciplines working independently on a common problem or question while interdisciplinary R&I involves interacting and working collaboratively from the outset.

[4] Wikipedia is a free online encyclopaedia, created and edited by volunteers around the world and hosted by the Wikimedia Foundation., see: https://www.wikipedia.org

[5] DBPedia is a project aiming to extract structured content from the information created in Wikipedia, see: https://www.dbpedia.org

[6] Wikidata is a collaboratively edited multilingual knowledge graph hosted by the Wikimedia Foundation, see: https://www.wikidata.org

knowledge graph[7] in combination with machine learning algorithms that assigns topics from the taxonomies of interest to any form of textual data (see more information below).

In this analysis, the text data consisted of the abstracts of SPF grants that were available in GtR. A total of 730 SPF grants were covered by GtR as of late August 2022.

The classification followed a 3-step process, with each step including a degree of automation and manual checks.

First, text data from SPF grant abstracts was classified based on Wikidata topics after which these initial results were filtered down to relevant topics only. The allocation of relevant topics per priority areas is summarised in Table 1. Most priority areas were sufficiently captured by a single Wikidata topic, with the exception of "Adolescence and mental health" which was captured by cross referencing the separate topics of "mental health" and "adolescence".

Table 1 Allocation of topics per priority area

Priority area	Topic (with Wikidata code)
Air quality	Air quality (Q56245086)
Bacterial plant diseases	Bacterial plant disease (Q9164481)
Cybersecurity	Computer security (Q3510521)
Mental health and adolescence	Adolescence (Q131774) and mental health (Q317309)
Modern slavery	Contemporary slavery (Q3369955)
(Research on) Productivity	Productivity (Q2111958)
Space weather	Space weather (Q584093)
Time Infrastructure / Measuring time	Horology (Q41767)

Second, the initial classification of SPF grants allowed for a subsequent analysis of the key words and phrases by priority area, to be used for the classification of all remaining grants in GtR not covered by SPF (referred to as UKRI grants hereafter). To carry out this step, key words were identified using a Rapid Automatic Keyword Extraction (RAKE) algorithm.[8] RAKE follows a three-step process:

- Keywords are extracted from contiguous sequences of words that do not contain irrelevant words (such as stop words)
- A score is calculated for each word based on its frequency as well as its co-occurrence with other words. Specifically, the score is calculated as the ratio of co-occurrence to frequency

[7] "Knowledge graphs (KGs) organise data from multiple sources, capture information about entities of interest in a given domain or task (like people, places or events), and forge connections between them", for more information see: https://www.turing.ac.uk/research/interest-groups/knowledge-graphs and https://www.textrazor.com/named_entity_recognition

[8] Rose, Stuart & Engel, Dave & Cramer, Nick & Cowley, Wendy. (2010). Automatic Keyword Extraction from Individual Documents. Text Mining: Applications and Theory. 1 - 20. 10.1002/9780470689646.ch1.

- The RAKE score for each keyword is calculated by summing the scores of its component parts
- Based on a combination of RAKE scores and manual inspection of SPF grants (to check which grants were being identified or not by the keywords), a set of key words was identified per priority area, summarised in Table 2.

Table 2 Summary of key words identified per priority area

Priority area	Keywords used
Air quality	Air quality
Bacterial plant diseases	Bacteria AND plant pathogens OR plant diseases
Cybersecurity	Cyber security, cybersecurity, computer security
Mental health and adolescence	Adolescent mental health, adolescence AND mental health (overall co-occurrence within abstracts)
Modern slavery	Modern slavery, slavery in the 21st century
(Research on) Productivity	Productivity (restricted to ESRC grants)
Space weather	Space weather, weather in space
Time Infrastructure / Measuring time	Atomic clock, molecular clock, clock

Third, the identified key words were used to formulate dictionaries per priority area. For all UKRI grants (i.e. non-SPF grants available in GtR), a document-term matrix was constructed using these dictionaries. In short, a document-feature matrix tabulates the coverage of certain features, in this case priory area-specific dictionaries, across all documents, in this case non-SPF project abstracts. This process automatically performs basic text mining tasks such as converting characters to lower case, removing stop words, and stemming words (reducing terms to their word stem, base, or root) to enable more accurate text analysis.

The result of this process is an overview of the occurrence of previously identified key words across project abstracts, based on which corresponding grants were assigned to one of the priority areas.

A set of random spot checks were carried out in order to ensure no grants were mislabelled (i.e., selecting a collection of grants at random to check their classification against their abstract). The total number of grants per priority area, for SPF and UKRI is summarised in Table 3 below.

Table 3 Number of grants per priority area - SPF compared to UKRI

Priority area	Number of SPF grants (N = 730)	Number of UKRI grants (N = 130,246)
Air quality	40	749
Bacterial plant diseases	13	109
Cybersecurity	11	805
Mental health and adolescence	15	195
Modern slavery	9	32
(Research on) Productivity*	19	255*
Space weather	25	225
Time Infrastructure / Measuring time	8	253

* Restricted to ESRC grants only

Appendix B SPF Programme Portfolio

The table below lists all of the SPF programmes awarded funding under Waves 1 and 2, as well as details of the Fund objectives they seek to address, the amount of SPF funding awarded, and the various lead and partner organisations (Councils, BEIS PSREs, Government Departments, agencies and devolved administrations) that were involved at the time of award. This section refers to BEIS for simplicity, as it was the department responsible at the time of the Fund's establishment, however, BEIS was dissolved on 7 February 2023, with its functions split into three new departments: Department for Science, Innovation and Technology (DSIT), the Department for Energy Security and Net Zero (DESNZ), and the Department for Business and Trade (DBT).

Table 4 SPF Programme Portfolio (Waves 1 and 2)

Wave	Programme name	Summary	Lead	Partner Council / BEIS PSRE	Gov Department Partners	Agility Obj.	MIDRI Obj.	Gov. Obj.	Cost (£m)
1	AI and Data Science for Engineering, Health, and Government	A multi-strand proposal to bring AI to bear on: digital twinning; healthcare; science and engineering; and the justice system. Delivered via the Alan Turing Institute. [Delivered in partnership with the Alan Turing Institute]	EPSRC	BBSRC, ESRC, MRC, NERC, STFC	DEFRA, Home Office, BEIS, DfT, DHSC	X	X	X	38.8
1	Analysis for Innovators	Business-led collaborations (including matched funding) to address low productivity by providing businesses with measurement and analysis capability. Builds on a successful pilot.	IUK	STFC and NPL		X	X		14.1
1	Clean Air: Analysis and Solutions	A portfolio of investments to improve UK capacity to understand and address low air quality. This addresses the current lack of cohesion in the current air quality community, building an interdisciplinary network which will move on from "easy wins" to new research and innovation challenges.	NERC & Met Office	EPSRC, ESRC, IUK, MRC, NPL	DEFRA, DfT and DHSC		X	X	19.6
1	Constructing a Digital Environment	A project to improve environmental modelling by constructing a sensor network and augmenting analytical and visualisation capability	NERC	EPSRC	DEFRA		X	X	10.4
1	EMBL-EBI	Investment in new IT facilities for the European Bioinformatics Institute. The EBI is the world leader in the analysis, storage, and dissemination of biological data. The new facilities will allow the EBI to maximise the opportunities provided by AI and be more open to collaboration with business.	BBSRC	MRC	DHSC (CMO)	X	X	X	44.5
1	Ensuring the Security of Digital	Funding for researchers and industrial "demonstrators" to address security weaknesses in the Internet of	EPSRC	AHRC, ESRC, IUK	DCMS and Home Office	X	X	X	30.6

Wave	Programme name	Summary	Lead	Partner Council / BEIS PSRE	Gov Department Partners	Agility Obj.	MIDRI Obj.	Gov. Obj.	Cost (£m)
	Technologies at the Periphery	Things by combining cyber and physical security with behavioural studies.							
1	Extreme Photonics Application Centre (EPAC)	A new facility incorporating a novel laser-driven radiation technique with applications in medicine, defence, and industry. The facility will put the UK at the cutting edge of the field. [Co-funded by the Ministry of Defence]	STFC		MoD	X	X	X	71.2
1	Human Cell Atlas	Competitive funding for research groups with the joint aim of mapping every type of cell in the human body. The UK's contribution to an international collaboration led by Harvard/MIT and the Sanger Institute. [Delivered with support from the British Heart Foundation]	MRC	EPSRC and IUK		X	X		6.7
1	Landscape Decisions	A project to deliver a new prototype landscape-scale decision-making framework that will be developed under future activities, by developing new approaches and building communities.	NERC	BBSRC and EPSRC	DEFRA		X	X	10.3
1	Living with Machines	Research into the social and cultural impact of the Industrial Revolution via collaboration between humanities researchers, data scientists, and other researchers. [Delivered in partnership with the Alan Turing Institute]	AHRC		DCMS	X	X	X	9.3
1	Physics of Life	A proposal to address the traditional divide between physics and life sciences, which presents a major obstacle to research into subjects ranging from cancer to antimicrobial resistance. This project will fund collaborative projects between physicists and biologists, building on the existing Physics of Life network.	EPSRC	BBSRC, MRC	BEIS	X	X	X	31.2
1	Transforming Productivity Research	A suite of projects to investigate the drivers of productivity growth and understand how these can be manipulated to improve economic growth and living standards.	ESRC	EPSRC, MRC	DHSC, DWP and BEIS	X	X	X	8.9
1	UK Animal and Plant Health	A call to fund research into plant pathogens. A first wave to be delivered by the John Innes Centre, focussing on Xylella fastidiosa; second wave wider in scope. Xylella and similar pathogens pose a severe risk to food production, the horticultural industry, and urban and rural landscapes.	BBSRC	NERC	DEFRA and Scottish Gov.	X	X	X	17.7
1	UK Climate Resilience	A set of calls across three related themes to understand how UK society and economy can be made resilient to climate change. Previous efforts	NERC & Met Office	EPSRC and ESRC	DEFRA		X	X	18.7

Wave	Programme name	Summary	Lead	Partner Council / BEIS PSRE	Gov Department Partners	Agility Obj.	MIDRI Obj.	Gov. Obj.	Cost (£m)
		have focussed on improving our ability to measure and forecast climate change; this project builds on that to understand the changes in behaviour, innovation, and government strategy required to address this change.							
1	UK Population Lab	One year's funding to scope work on a new Population Lab, including a new "spine" for handling administrative data, and a new birth cohort for longitudinal studies.	ESRC	EPSRC, MRC, NERC	DWP and DHSC	X	X	X	2.1
2	A food systems approach for healthy people and a healthy planet	Competitive research calls for consortia to take a 'farm to fork' systems approach to food production, understanding nutrition needs within society and how to meet them through environmentally friendly food production. [Led by the GFS Programme]	BBSRC	MRC, NERC and ESRC	Defra, DHSC and FSA	X	X	X	47
2	Adolescence, Mental Health and the Developing Mind	A programme of workshops and open research calls designed to better understand the developing adolescent mind, how internal and external factors shape it, and how these impact on lifelong mental health, educational attainment, identity, social relationships and behaviour.	MRC	AHRC and ESRC	DfE, DCMS and Welsh Gov.		X	X	35
2	Clean Air: Future Challenges	Research grants and business-led competitions to explore the effects and mechanisms of air pollution indoors.	NERC & Met Office	IUK, ESRC, EPSRC, MRC, STFC and NPL	Defra, Scottish and Welsh Gov, DHSC and DfT		X	X	22
2	Greenhouse Gas Removal Demonstrators	This will provide a world leading research and innovation programme that will establish greenhouse gas removal (GGR) demonstrator facilities. These will demonstrate the effectiveness, cost, and limitations of large-scale GGR. Findings will be integrated by a Directorate Hub, which will also provide underpinning research to address the business, environmental, social, ethical, and governance issues, and support the progress of GGR technologies to readiness.	NERC	AHRC, BBSRC, ESRC, EPSRC and IUK	BEIS and Defra		X	X	31.5
2	Harnessing Exascale Computing (ExCALIBUR)	A collection of commissioned research and competitive tenders to ensure future simulation codes and algorithms are resilient enough to work with / use advanced supercomputer architecture.	EPSRC & Met Office	STFC, NERC and MRC and UKAEA	MoD		X	X	45.8
2	National Interdisciplinary Circular Economy	Research grants to build a multidisciplinary research community that can take a systems view of resource flows (e.g. those within the food, water or textiles sectors) to assess risks and benefits associated with the	EPSRC	NERC, AHRC and ESRC	Defra	X	X	X	30

Wave	Programme name	Summary	Lead	Partner Council / BEIS PSRE	Gov Department Partners	Agility Obj.	MIDRI Obj.	Gov. Obj.	Cost (£m)
	Research Programme	circular economy and make recommendations that inform policy making and accelerate change.							
2	National Timing Centre	This programme will deliver the world's first demonstration testbed of a resilient distributed national time scale traceable to global standards along with mechanisms to support the early adopters and those exploring new technologies. It will also act as a blueprint for a future resilient timing infrastructure in the UK.	NPL	IUK	MoD, BEIS and DfT	X	X	X	30.3
2	Nucleic Acid Therapy Accelerator (NATA)	A challenge-led R&D programme based around the delivery and synthesis of nucleic acid medicines. [Delivered in partnership with the Harwell Research Campus].	MRC		DHSC and BEIS (Office for Life Sciences)		X	X	30
2	Policy & Evidence Centre for Modern Slavery & Human Rights	Employing researchers to carry out commissioned work and issue open research calls to tackle Modern Slavery within a new Policy and Evidence Centre.	AHRC	ESRC	Home Office	X	X	X	10
2	Protecting Citizens Online	A research hub which will issue research calls and deliver knowledge and tools to mitigate four important categories of online harm: privacy abuses and inappropriate uses of personal data; malign influence and disinformation; online fraud and fake identity; cyber-bullying and harassment.	EPSRC	ESRC and AHRC	DCMS, Home Office and Cabinet Office (National Security)	X	X	X	18.3
2	Quantum Sensors for Fundamental Physics (QSFP)	Research calls for cross-disciplinary consortia to develop quantum sensor technology and train the next generation of researchers, engineers and scientists.	STFC	EPRC and UKSA and NPL			X	X	40
2	Space Weather Innovation, Measurement Modelling and Risk (SWIMMR)	Commissioned research and open calls designed to provide a strategic UK approach to Space Weather, transitioning research into operations, according to user needs. This includes advancing UK understanding of the risks of Space Weather and mitigating actions which can be taken.	STFC	NERC and Met Office	BEIS, MoD and DfT	X	X	X	20
2	Sustainable Management of UK Marine Resources	A research call for proposals to understand the importance to the economy and to society of different components of marine natural capital and the services they underpin, enabling more comprehensive evaluation of the trade-off potential under different management scenarios, and identifying interventions that will improve the marine environment and produce sustainable and resilient outcomes.	NERC	ESRC	DEFRA and Scottish Gov		X	X	12.4

Wave	Programme name	Summary	Lead	Partner Council / BEIS PSRE	Gov Department Partners	Agility Obj.	MIDRI Obj.	Gov. Obj.	Cost (£m)
2	Tackling multimorbidity at scale: Unpicking disease clustering biological pathways and trajectories	Funding for open research calls to move away from a one-disease, one mechanism approach and explore disease "clusters" that make up multimorbidity (the concurrence of two or more health conditions in an individual) and how they are caused. Findings will be consolidated in a multimorbidity databank. [Co-funded by DHSC and NIHR]	MRC	ESRC	DHSC		X	X	10
2	The Advanced Pain Discovery Platform: Mapping the complexity of chronic pain	A collaboration with Versus Arthritis to fund charities and commercial partners which can shed new light on the mechanisms of pain and how and why there is so much variety in its lived experience. [Co-funded by Versus Arthritis]	MRC	BBSRC, IUK and ESRC		X	X	X	12
2	Towards a National Collection: Opening UK Heritage to the World	A suite of commissioned and open call research projects designed to improve access to AHRC's Independent Research Organisation's archives and collections, building towards a unified virtual 'national collection'.	AHRC		DCMS		X	X	18.9
2	Transforming Productivity: National Institute of Excellence	The institute will provide a convening hub for wider research as well as undertaking its own research, bespoke analysis and evaluations to understand what action is required to solve the UK's productivity challenges. Central to the institute's capability will be designing and testing interventions: translating findings and scaling-up solutions in direct collaboration with business and policy-makers.	ESRC	IUK and NPL	HMT, BEIS and DWP		X	X	42.2
2	Trustworthy Autonomous Systems	This investment will fund a new research hub and surrounding nodes to drive forward cross disciplinary fundamental research into the design, development, curation, verification and validation of autonomous systems to enable trust, and to ensure that they are safe, reliable, resilient, and ethical. This is an important step to de-risk this emerging technology.	EPSRC	IUK, STFC, AHRC	Cabinet (National Security), MoD, DCMS and DfT	X	X	X	33.9
2	UK Centre of Evidence Implementation in Adult Social Care	This project will offer an open call to deliver a UK Centre of Evidence Implementation which should drive improvements in social care practice and help prevent escalation of need. [Co-funded by the Health Foundation]	ESRC		DHSC, Welsh Gov, Scottish Gov, N. Irish Gov, MHCLG, Cabinet Office		X	X	7.5

Appendix C SPF Theory of Change

C.1. Introduction

This section presents a Theory of Change (ToC) for SPF. It was developed based on analysis of the SPF Business Case and programme descriptions, plus evidence from scoping interviews, workshops and feedback from the Evaluation Advisory Committee.

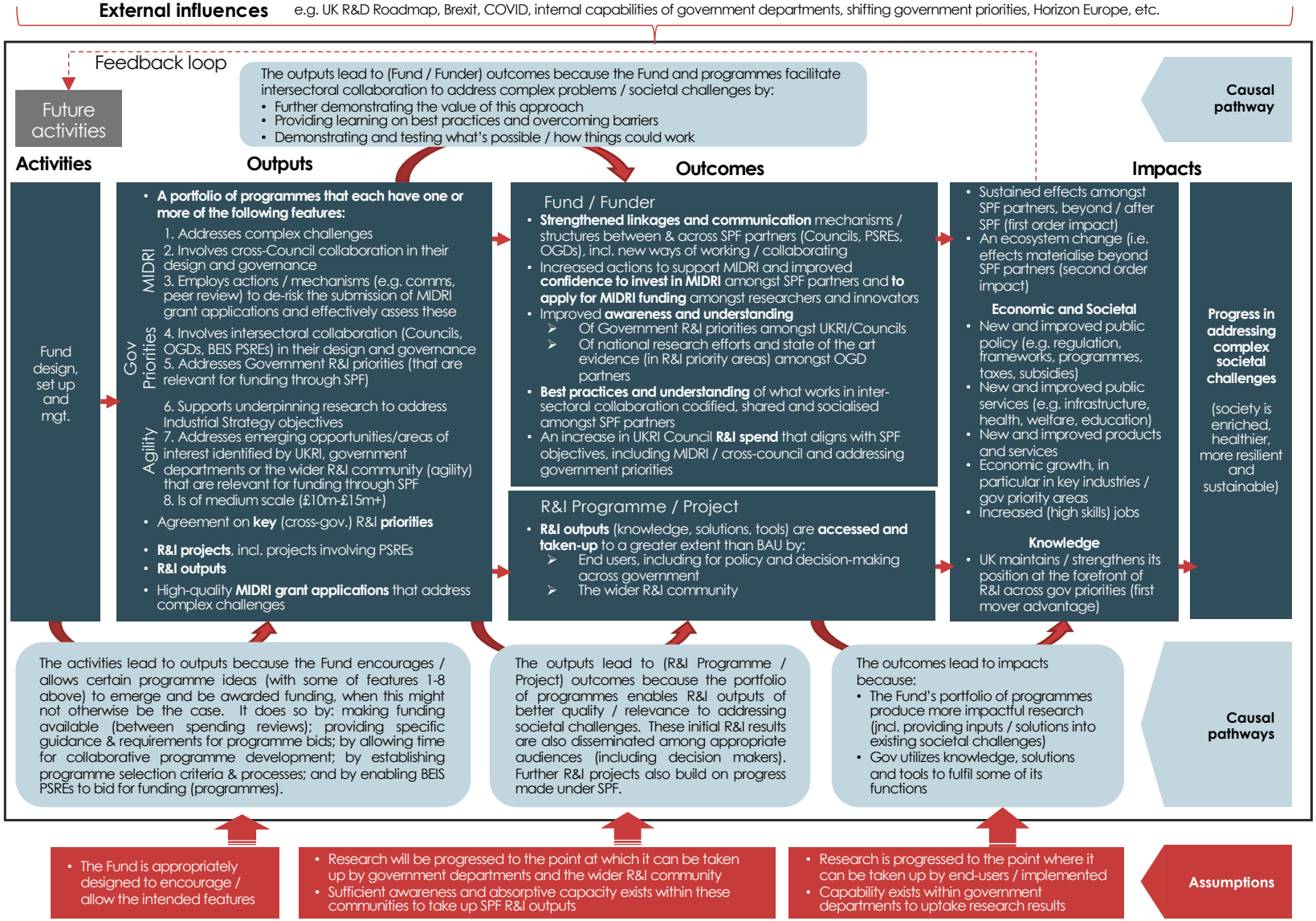
Figure 2 presents a high-level logic model for the Fund, including (in the dark blue boxes on the second row) its expected outputs, outcomes and impacts. These focus on contributions towards Fund-level objectives, drawing on results that may materialise at programme/project level when relevant.

The diagram also includes (light blue boxes in the first and third rows) the causal pathways that would lead from one stage to the other (i.e. from outputs to outcomes, or from outcomes to impacts), as well as (red boxes in the final row) the assumptions that underpin those pathways. Finally, the diagram also includes a set of external factors that influence the results (either negatively, positively or in an uncertain way).

The logic model provides a (simplified) visual summary of the Fund's logic and should be viewed in conjunction with the Theory of Change narrative (which follows). The logic model is explained in full in these subsections, which among other things expand on the expected impacts from the Fund, providing more detail of the categories presented in the diagram.

Every element of the ToC was translated into a series of indicators to be addressed through the evaluation.

Figure 2 SPF Theory of Change



C.2. Inputs and activities

There are several inputs and activities involved in the **implementation of the Fund**:

- At the risk of stating the obvious, the main input of the Fund is the provision of **funding** and funding decision **criteria** for programme selection, in line with its three high-level objectives.
- Additionally, BEIS/OGD/UKRI priorities, **strategies and policy** papers have also served as a reference point for programme bid development and for the selection of the portfolio. In Wave 2, specifically, there was work done by the SPF team and GO-Science to support the identification of government R&I priorities, with programme leads / bidders invited to draw upon this intelligence in identifying and developing programme ideas.
- Another key input / activity at the Fund level has been the **review and selection of programmes** in alignment with one or more of the three high-level objectives.
- The Fund has also set up an **SPF Programme Managers' Forum,** which meets regularly to provide guidance and support, as well as an opportunity for knowledge exchange (on implementation, but also monitoring and evaluation activities at the programme level).
- Finally, SPF has established its own **Monitoring and Evaluation Plan**, setting out the approach to evaluation at the Fund level, as well as the data collection, monitoring and evaluation activities required by individual programmes (alongside guidance and templates for programme-level monitoring and evaluation plans).

By design, **the SPF programmes** are implemented in a decentralised manner, with a high degree of autonomy for programme leads (with the SPF board providing oversight in terms of financial profile and any other issues emerging across programmes). The individual programmes are not the main focus of this evaluation, but for completeness we list below the inputs and activities that are expected at programme level, given that some Fund level outputs and outcomes will materialise here (specifically, R&I outputs and their outcomes).

The programme-level inputs and activities include:

- Assessment of R&I priorities to inform programme design and implementation, and the development of **programme proposals and business cases**, including engagement with programme partners (government, academic and business).
- **Expertise** (embedded within people, documentation and processes) on how to deliver on the three objectives, including actions and mechanisms to encourage MIDRI.
- **Co-funding and existing infrastructure**. This has varied from programme to programme. For instance, the UK Centre for Evidence Implementation in Adult Social Care is co-funded by the Health Foundation (and ESRC), while the Transforming Productivity Research SPF programme offers research funding within the existing Productivity Centre (headquartered at the Alliance Manchester Business School, and funded by the ESRC), and the Human Cell Atlas SPF programme provides access to a research infrastructure of the same name (an international activity creating a comprehensive reference map of all human cells as a basis for both understanding human health and diagnosing, monitoring, and treating disease).
- The programmes also offer **staff** (to run and monitor programmes), and advisory boards to provide strategic steer. Those advisory boards often include participation from the OGDs. Some programmes have also established Programme Directors and Champions. Many programmes will also be commissioning external monitoring and evaluation activities.

- Programmes are also in charge of setting up the funding decision **criteria** (incl. inclusion of PSREs) **and processes** (including panel composition) for the review and selection of projects (when relevant), as well as the commissioning of work.
- It is also expected that programmes will put in place **knowledge exchange** activities and facilitate programme synthesis and dissemination. These could in turn help to further support the multidisciplinarity of results and support uptake of knowledge (including among OGDs).

C.3. Outputs

The activities described in the previous section should lead to expected outputs (described below) because the Fund encourages and allows certain programme ideas to emerge and be awarded funding, when this might not otherwise be the case. It does so: by making funding available; by providing specific guidance and requirements (in line with SPF objectives) for programme proposals; by allowing additional time for collaborative programme development across communities; by establishing programme selection criteria and processes; and by enabling PSREs to bid for funding.

The main output then expected from the Fund is a **portfolio of programmes that embody** (or are aligned with) **one or more of its three high-level objectives** (noting that there may be some overlap or interconnectedness between these objectives):

- Drive an increase in high quality multi-disciplinary and inter-disciplinary research and innovation (MIDRI)
- Ensure that UKRI's investment links up effectively with cross-departmental research and innovation priorities and opportunities
- Responding to strategic priorities or opportunities

To this end, programmes are expected to have one or more of the key features listed against the three objectives below.

In alignment with the MIDRI objective, programme features may include (i) that it addresses complex challenges (including through MIDRI), and / or (ii) that it involves cross-council collaboration in its design and governance, and / or (iii) that it takes actions / employs mechanisms to de-risk the submission of MIDRI grant applications and effectively assess these. On the latter point, these actions / mechanisms are expected to be quite varied, from communications (i.e. the way the programme and competitive calls, if relevant, are advertised by funders), all the way to setting up peer review processes to encourage MIDRI grant applications (either relying on existing mechanisms within UKRI Councils or enhancing / modifying these to address this objective of the Fund).

The Fund has not been prescriptive about the way programmes should set up their research agendas or encourage and assess MIDRI grant applications (where relevant), but it is expected to have 'nudged' them in that direction, improving the efficacy of the system in assessing MIDRI applications. The evaluation will seek to identify when / if this happened in practice.

In alignment with the government priorities objective, programme features may include: (i) that it involves intersectoral collaboration (between Councils, OGDs and PSREs) in its design and implementation (including governance); and / or (ii) that it addresses Government R&I priorities (as stated, for example, in the Areas of Research Interest). There is also an

expectation that programmes might align with more immediate priorities (as set out in the Industrial Strategy[9]) [reflected in the system agility objective].

As stated in the Business case, Wave 2 of the Fund was expected to produce a 'government-wide' agreed list of key (cross-government) R&I priorities. We understand that this happened in coordination with GO-Science, as described above.

In alignment with the system agility objective, programme features may include: (i) that it supports underpinning research that could help to address the Industrial Strategy objectives[10]; and / or (ii) that it addresses emerging opportunities / areas of interest identified by the R&I community (i.e. by UKRI, Councils, government departments and researchers & innovators) (reflecting the agility of the funding)[11]; and / or (iii) that it is a medium scale (£10m-£15m+) investment.

As stated above, there are expected to be cross-overs between objectives with, for instance, a particular programme addressing one of the features related to the MIDRI objective (e.g. complex challenges) via addressing an emerging government priority (government priorities objective).

Across all objectives, the Fund is also expected to generate a portfolio of **R&I projects** (through programme work packages, competitive calls and commissioning), some of which are expected to involve PSRE participation. The Fund is also expected to lead to high-quality MIDRI grant applications, which may arise as a consequence of programmes addressing any of the three high-level SPF objectives. The portfolio of projects will, in turn, generate a portfolio of **R&I project outputs**. Given the nature of the programme portfolio (as described above), these R&I outputs are expected to be more geared towards addressing societal challenges and government R&I short- and long-term priorities, in comparison with business as usual.

[9] https://www.gov.uk/government/publications/industrial-strategy-building-a-britain-fit-for-the-future

[10] The Fund is expected to "increase investment in fundamental research and innovation priorities that push the frontiers of knowledge and will deliver the longer-term pipeline of outputs that will be critical to achieving the ambitions of the ISCF and the wider Industrial Strategy".

[11] SPF is expected to help re-balance the UKRI budget, which is currently dominated by activities not directly / purposefully linked to the grand challenges, providing more agility to the system to address emerging needs. The programmes themselves may also have been able to re-adjust / adapt to emerging needs and priorities (or changes natural within the research discovery process), with extra agility achieved *within* programmes (not only as a consequence of the extra resources injected to the system via the Fund). This programme-agility was not an explicit intention of the Fund, but the extent to which this has occurred anyway, will be investigated as part of the evaluation.

C.4. Outcomes

The outputs set out above are expected to lead to two groups of outcomes:

- Outcomes that relate to changing the way that Councils, PSREs and OGDs collaborate to attain common R&I objectives
- Outcomes that relate directly to the generation of knowledge, tools and solutions for addressing societal challenges and government R&I short- and long-term priorities.

On the first group of outcomes, the Fund is expected to strengthen linkages and communication mechanisms / structures between and across partners (Councils, PSREs, OGDs) involved in SPF programmes, including through new ways of working / collaborating between these partners. Collaboration among these organisations is not new (as illustrated by the examples of the Strategic Coordination of Health Research and the Energy Innovation Board, mentioned in the main report), but the SPF is expected to create a broader spectrum of sustained connections within the programme and across Councils and Government Departments so that e.g. government can turn to UKRI to support their R&I objectives.

We understand from conversations with SPF leads (via workshops) that the Fund has indeed encouraged greater working between different Councils and other organisations. On the former, having access to a separate funding 'pot' has simplified cross-Council working (removing the pressure associated with allocating core finding to joint activities and ambitions, as predicted in the Business Case). The programmes are also implementing different ways of engaging with Government Departments, with government representatives inputting to business cases or programme design, participating in project selection (for competitive calls) and / or sitting on advisory boards, to an extent that is not normally seen.

This is an ongoing learning process and the Fund is expected to lead to a **better understanding of what works in inter-sectoral / cross-discipline collaboration**, and for this to be codified, shared and socialised amongst partners in some shape or form (to further facilitate sustained effects or an ecosystem change, as discussed below within the section on impacts).

Involvement in SPF is also expected to **improve awareness and understanding** of:

- Government R&I priorities amongst UKRI/Councils
- National research efforts and state of the art evidence (in R&I priority areas) amongst OGDs

In line with the system agility objective, the Fund is also expected to lead to an increase in **UKRI Council R&D spend** that aligns with government priorities (including those of the Industrial Strategy).

Finally, and in line with the MIDRI objective, the Fund is also expected to increase actions to support MIDRI (e.g. setting up dedicated workshops to bring together researchers from different disciplines, synthesising the evidence that may be emerging from separate research groups, or disseminating results to wider research communities) and, ultimately, to improve confidence amongst SPF partners and participants to invest in MIDRI. Whether the setup of the Fund has been a sufficient condition to incentivise further support to MIDRI is a strong assumption behind these outcomes and will be further investigated in the evaluation.

On the second group of outcomes, it is expected that the R&I outputs (knowledge, solutions, tools) generated with support from the Fund are accessed and taken-up by the R&I

community and by end users, including for policy and decision-making across government, and that this happens to a greater extent compared with business as usual, in line with Objectives 2 and 3. This is expected to happen because the portfolio of programmes enables R&I outputs of better quality / relevance to addressing societal challenges and government R&I priorities, but also because of the scale of investment involved in each programme.

This is expected to be reinforced by the nature of programme engagement with key audiences (e.g. government departments) who have the ability to provide input and direction to the research agendas by the means described above. Whether this is enough to achieve R&I outputs of better quality / relevance is something that would need testing via the evaluation.

Finally, further R&I projects (funded by the public or the private sector) are expected to build upon progress made in SPF to facilitate further attainment of impact.

C.5. Impact

The first group of outcomes (those related to changing the way that Councils, PSREs and OGDs collaborate to attain common R&I objectives) are expected to lead to:

- Sustained effects (collaborations / interactions) amongst SPF partners, outside of SPF (first order impact)
- An ecosystem change (i.e. effects materialise beyond SPF partners) (second order impact)

This in turn would lead to future activities. For instance, one could expect to see the emergence of new national coordination structures with membership from UKRI, central government, other government, third sector, industry, etc, building upon the SPF experience. Similarly, the experience of the Fund could lead to an increase in MIDRI-rich programmes.

The second group of outcomes (those related directly to the generation of knowledge, tools and solutions for addressing societal challenges and government R&I priorities) are expected to lead to economic, societal and knowledge-related impacts.

In terms of **knowledge,** it is expected that the UK maintains / strengthens its position at the forefront of R&I across gov priorities (first mover advantage).

(First order) Economic and societal impacts, in turn, are expected to materialise in the form of:

- New and improved public policy (regulation, frameworks, programmes, taxes, subsidies)
- New and improved public services (e.g. infrastructure, health, welfare, education)
- New and improved products and services

Furthermore, there is also the expectation that some of the R&I outcomes and impacts listed above may lead to economic growth in the longer term (in particular in key industries / gov priority areas) and / or to increased (high skills) jobs. Finally, the Fund is ultimately expected to support progress in addressing complex societal challenges (helping to create a society that is enriched, healthier, more resilient and sustainable) (second order impact).

C.6. External factors

There are a series of external factors that could influence the attainment of outcomes and impacts, in a positive, negative or uncertain way. We have identified five main categories:

- **UK R&D Roadmap**: The document (currently under consultation) acknowledges the desire to keep on investing in programmes addressing cross-departmental government priorities, when needed. This direction of travel could serve as an enabler of impact for SPF as it increases the likelihood that further support may be available to progress on the R&I outcomes advanced by the programme.
- **Shifting government priorities**: The intention is that SPF — by providing additional funding outside of core budgets and normal spending review cycles — will provide UKRI with greater agility to respond to shifting government priorities. However, the extent and speed with which priorities shift could test the Fund's agility to respond, and may also impact upon levels of government engagement throughout the life of individual programmes (in implementation / governance, but also in the degree of uptake and use of R&I outputs).
- **Brexit**: There is uncertainty as to the effects that Brexit may have in the economy and on the R&I landscape (including, for instance, access to talent from the EU).
- **COVID-19**: The COVID-19 pandemic generated some delays in the delivery of the projects and programmes (and consequently on the achievement of outputs and outcomes), and / or called for the redirection of originally planned activities. The extent of this potential delay or change of course was considered when analysing the results emerging in the interim and final evaluation. The pandemic also generated adverse economic effects, and unknown effects on wider R&I expenditure. On the business side, a study commissioned by Innovate UK shows that around 1 in 9 firms (UK grant holders) stopped all of their R&D activities during the lockdown period[12]. Furthermore, around 65% of firms reduced the scale of their R&D activities during the lockdown period.
- **Internal capacities / capabilities of government departments:** This may pose problems of coordination and continuity for the programmes but could also affect negatively the probability of uptake of the knowledge, solutions and tools developed (or at least may require further efforts from the programme leads to support such dissemination).

[12] https://innovateuk.blog.gov.uk/2020/09/21/one-size-doesnt-fit-all-in-terms-of-rd-and-innovation/?elqTrackId=3952FF02B71AD5695353EEB6096BB2A8&elq=883ae8724a5f42b9a2772e1ffc72d6b8&elqaid=1597&elqat=1&elqCampaignId=925. Accessed 26 October 2020.

Appendix D Longitudinal case studies

D.1. Introduction to the case studies

As part of the SPF Fund evaluation, a series of eight longitudinal case studies were developed, each focusing on a specific SPF programme.

The first iteration of each of these case studies was developed for the baseline and interim process evaluation (published in January 2022). At this point the focus was primarily on describing the programmes and their origins, as well as any early learnings and preliminary outputs.

A second iteration of each case was then developed as part of the interim evaluation (2023). In each, we revisited the programme in question and updated and revised the case with additional evidence about outputs, outcomes and direction of travel in terms of impact achievement.

For the final evaluation (2025), we have returned to each case again, for a further update, and have focused in particular on collecting information on any new developments and achievements, plus any evidence of wider uptake and impact from the programmes and their projects.

Each of the cases was developed on the basis of desk research, combined with interviews with key stakeholders (programme leads and partners from Councils, PSREs and government, plus others). Approximately 50 interviews were undertaken across the eight cases at each stage.

The case studies should not be viewed as evaluations of the programmes, but rather a summary of key features and achievements. Many individual programme evaluations are completed and key findings from these (where available) have been incorporated in this Final update.

Each case follows a standard structure and looks to address a series of questions that are relevant to the SPF evaluation. Each starts by exploring how the programme was designed and implemented. Each then discusses outputs, outcomes and impact, based on the 3 objectives of the fund, and finishes by exploring what further results and impact is expected in the future.

Drafts of seven of the case studies (concerning the BPD, SDTaP, Productivity Institute, Clean Air, AMHDM, SWIMMR, and MS PEC programmes) have been reviewed by the relevant programme lead, with their comments addressed in the version presented in this appendix. We did not receive a response from the programme leads for the last case study (NTC).

D.2. Adolescence, Mental Health and the Developing Mind

SPF Wave 2	SPF funding amount: £35 m	Programme start and end date 01/08/2019 - 31/03/2026
Lead Council / PSRE: MRC	Other Council / PSRE: AHRC and ESRC	Government departments: DfE, DHSC, MoJ and the Scottish and Welsh governments
Other partners • National Children's Bureau (NCB) • Wellcome Trust		
Key objectives • Establishment of a UK-wide multidisciplinary and multi-sector research community in adolescent mental health and the developing mind. • Delivery of high quality, novel research programmes that generate new knowledge of adolescent mental health and the developing mind. • The development and adoption of novel methodology, tools and resources to support the broader field of adolescent mental health research. • Long-term potential for contributing to evidence-based policy and practice in adolescent mental health and wellbeing. • The promotion of Patient and Public Involvement and Engagement (PPI&E) in adolescent mental health research.		
Main phases • Community building and stakeholder engagement • Flagship research programmes • Methodological development • Cross-cutting knowledge mobilisation		

D.2.1. Summary

This case study explores the progress, achievements, and lessons learnt emerging from the Adolescence, Mental Health and the Developing Mind programme, funded by the Strategic Priorities Fund (SPF). The case study is informed by interviews with nine participants from both the funding councils and government departments involved in the programme. Note that, firstly, most interviewees have not been involved with the programme since its planning stage or launch and, secondly the programme is still ongoing until March 2026 – which both limited the scope of topics interviewees felt able to comment on.

Adolescence is a vital but often misunderstood time for mental health. In fact, most mental health issues appear before age 24: A 2020 NHS Digital Survey showed that around one in six young people aged 11-16, and one in five young adults aged 17-22, likely have a mental

disorder, with young women being particularly affected.[13] Understanding risk and resilience factors during this period is key to helping young people thrive. Early intervention is essential for promoting positive mental wellbeing and managing mental health problems effectively. The Adolescence, Mental Health and the Developing Mind programme's emphasis on multi- and interdisciplinary research is key in addressing challenges concerning adolescent mental health and in developing preventative interventions that promote good mental health and treat mental health issues, such as eating disorders. The programme has led to a diverse range of projects addressing complex challenges in adolescent mental health such as the increasing prevalence of loneliness, the impact of social media on well-being, and mental health disparities faced by marginalised groups. The programme fostered interdisciplinary collaboration by integrating diverse expertise into individual projects and in board membership, valuing arts and humanities within a field often more science-focused, attracting a broader range of researchers, and enabling co-production.

While the programme was launched under the previous Conservative government, the projects and the overall programme also strongly align with the current government's research and innovation (R&I) priorities, particularly those of the Department of Health and Social Care (DHSC) and the Department for Education (DfE), such as 'An NHS fit for the future'[14], 'Safer Streets',[15] and 'Break Down Barriers to Opportunity'.[16] By supporting research that aims to improve the mental health and well-being of young people, the programme contributes to broader government goals of ensuring that young people can participate in the education system and achieve their full potential. The programme has also enhanced researchers' understanding of government priorities and promoted the involvement of all disciplines in mental health research.

However, some challenges in creating multi-disciplinary teams remain, including a more genuine integration of arts and humanities into mental health research. Knowledge mobilisation and stakeholder engagement remain somewhat challenging, and there are some concerns about output uptake and the need for more funding to sustain them. Resourcing, time constraints, establishing a common language across disciplines, and understanding policymaker's language pose some further difficulties. As the programme continues until March 2026, further activities are planned, including a final conference to showcase impact case studies and creative outputs. Therefore, additional learnings and takeaways will emerge further down the line, including around wider impacts and potential ecosystem changes.

D.2.2. Introduction

Overview

[13] UKRI (n.d., a). Adolescence, mental health and the developing mind. Accessible at: https://www.ukri.org/what-we-do/browse-our-areas-of-investment-and-support/adolescence-mental-health-and-the-developing-mind/

[14] https://www.gov.uk/missions/nhs

[15] https://www.gov.uk/missions/safer-streets

[16] https://www.gov.uk/missions/opportunity

Adolescence is a critical period for mental health – understanding risk factors and early intervention through multidisciplinary research are essential for promoting well-being and managing mental health challenges during this stage. The Adolescence, Mental Health and the Developing Mind programme is a £35 million initiative running from 2019 to 2026, funded by the UK government's Strategic Priorities Fund (SPF). Led by the Medical Research Council (MRC), in partnership with the Arts and Humanities Research Council (AHRC) and the Economic and Social Research Council (ESRC), the programme aims to investigate the emergence of mental health problems in young people, identify factors contributing to resilience or susceptibility, and develop early preventative interventions to promote positive mental well-being and treat mental health issues. According to the Bidding template for the SPF Wave 2, this programme was intended to build on as well as enhance activity of existing investments including the UKRI Mental Health Research Networks, MRC Mental Health Data Pathfinder Project[17], and mental health projects being undertaken within ESRC/MRC's CLOSER initiative in population science.[18] A key aspect of the programme is its multi-disciplinary approach, bringing together expertise from medicine, biology, social science, arts, and humanities.

Programme workstreams and awards

The programme operates through four interconnected workstreams: Flagship Research Programmes, Methodological Development, Community Building, and Stakeholder Engagement and Knowledge Mobilisation. These workstreams facilitate collaborative research, the development of new research methods and tools, and the translation of research findings into policy and practice. To date, the programme has awarded grants across several funding opportunities: £1.06 million for Engagement Awards in February 2020 (11 awards), £400,000 for COVID-19 rapid knowledge mobilisation in September 2020 (two awards), £24 million for Research Programmes in September 2021 (seven projects), and £8.15 million for Methodological Innovation in November 2022 (13 awards).

- The Engagement Awards are focused on fostering multi-disciplinary collaborations to explore research challenges related to adolescent mental health, including understanding risk and resilience factors, and the impact of digital environments. The goal of the awards was to pilot projects, build stakeholder partnerships, and share knowledge, laying the groundwork for larger research initiatives within the broader programme.
- Projects funded under the COVID-19 Rapid Knowledge Mobilisation call supported the rapid mobilisation of research to address the well-being and mental health needs of adolescents during the COVID-19 pandemic. Both awards emphasised co-production with young people, ensuring resources were relevant and engaging for their specific needs,

[17] The awards were designed to be used flexibly by the institution to fund preliminary-stage projects to support the development of a mental health data and informatics resource in the longer term.

[18] The ESRC and MRC's CLOSER initiative, now part of Population Research UK (PRUK), is a UK resource focused on enhancing the use and impact of longitudinal population studies across social, economic, and biomedical sciences.

which included the design and development of engaging and accessible multimedia resources.

- Four-year projects under the Research Programmes call focus on a range of interdisciplinary programmes of original empirical research in adolescence, mental health and the developing mind. The projects aim to generate a new understanding of the developing mind to enable young people to flourish. According to one interviewee these projects had some delays due to the COVID-19 pandemic.
- Projects under the Methodological Innovation call focus on developing and embedding new research methods, tools, measures and resources to advance the overall field of adolescent mental health research.

Notably, the COVID-19 Rapid Knowledge Mobilisation call was a deviation from the business case, where a portion of the knowledge mobilisation budget was rapidly deployed against an emerging need. As the programme started in 2019, there were unavoidable delays due to the pandemic which means there are limited findings and outputs to reflect on for the Research Programmes and Methodological Innovation projects, many of which are still ongoing (for instance, some projects are still waiting for clinical trials to end as part of their research).

Relevance and breadth of topics

The research under the Adolescence, Mental Health and the Developing Mind programme is particularly crucial given the current crisis in child and adolescent mental health in the UK, with rates of probable mental disorders having increased since 2017 and remaining high post-pandemic.[19] According to the Bidding template, this programme sets out to examine complex and multifactorial problems, which cut across governmental department remits and several priority research areas. Looking at the list of projects funded under the Research Programmes and Methodological Innovation, the projects address pressing societal challenges covering a range of interconnected issues in adolescent mental health. This includes loneliness (both in digital and real-world contexts), the impact of social media on well-being, gender and sexual identity, emotional understanding and expression, mental health of marginalised groups, adverse childhood experiences, and the development of preventative interventions. Overall, participants described funded projects as ambitious and complex, noting that each one may have up to ten workstreams. One interviewee complimented the breadth of the different types of projects, some of which include the development of games or focussing specifically on schools and universities.

Relevance to government departments and government support

The research area of adolescent mental health cuts across several government departmental remits with current policy and practice implications. To various degrees, the DfE, the DHSC, the Ministry of Justice (MoJ), the UK Home Office as well as the Welsh and Scottish Governments were engaged throughout the bid development, reflecting their

[19] NHS England (2021). Mental Health of Children and Young People in England 2021 - wave 2 follow up to the 2017 survey. Accessible at: https://digital.nhs.uk/data-and-information/publications/statistical/mental-health-of-children-and-young-people-in-england/2021-follow-up-to-the-2017-survey

priorities. According to interviewees, multiple government departments provided letters of support for the business case (DfE, DHSC, MoJ and the Scottish and Welsh governments). They are also represented in the programme via the programme's Research and Stakeholder Advisory Board (RSAB), various dissemination events, and through the leadership of the programme's current Project Director (see more below under Programme design and delivery). Interviewees also provided concrete examples of how the programme is both relevant to government priorities and useful to a range of government stakeholders. For instance, it aligns with government priorities (particularly of the DHSC and DfE) and missions for 'An NHS fit for the future', 'Safer Streets', and 'Break Down Barriers to Opportunity'. The programme also aligns overall with government goals to ensure that young people can participate in the education system. This is linked to the longer-term potential to support productivity goals, by scaling up mental health support.

D.2.3. Programme design and delivery

Intersectoral working and collaboration

Overall, interviewees provided a positive assessment of the structure and management of the programme, with interviewees viewing the intersectoral approach as positive, with the MRC playing a key organising role and the Project Director being highly valued for their expertise.

The programme is led by a research council, MRC, in partnership with two other councils, AHRC and ESRC. The three councils had prior experience of successfully managing cross-council funding calls together (e.g., UKRI mental health networks, Global Challenges Research Fund (GCRF) and Newton Fund calls) and, therefore, planned to adopt a similar working model for the Adolescence, Mental Health and the Developing Mind programme. It was reported that research councils already had an established working relationship on mental health projects and were very open to cross-disciplinary work given their past collaborations. Council involvement includes connecting relevant people, sharing learning with colleagues within their respective council and contributing to communications. The collaborative intersectoral working generated via the leadership of the three councils was perceived as very positive by interviewees.

Overall, the programme is viewed as well-organised, with effective collaboration among research councils and a shared vision. Positive examples of cross-sectoral working include partnerships with the National Children's Bureau for knowledge mobilisation, and collaboration with the Wellcome Trust to build on insights on lived experience involvement from the SPF.

Further delivery and operational functions of the programme include the following:

The programme delivery was overseen by an executive group. The Senior Responsible Officer (SRO) for the Adolescence, Mental Health and Developing Mind programme chairs the executive group, overseeing delivery of the programme in line with its objectives.

The programme has a Programme Director who is seconded on a part-time basis to MRC. The current Programme Director has been leading the programme since September 2023, taking over from the previous Programme Director who was in the role from 2020 to 2023. The Programme Director role was considered essential due to its function in steering, supporting, and ensuring the programme's effectiveness and impact. The current Programme Director is seconded from a government department and brings valuable sector expertise and

government contacts, with a particular emphasis on strengthening connections with policy makers.

The programme also includes a Research and Stakeholder Advisory Board (RSAB) which provides expert guidance. The RSAB meets every six months, with the latest meeting at the time of writing (May 2025) having taken place in February 2025. Members of the RSAB include academics and stakeholder representatives covering policy and practise across a range of sectors. RSAB member contributions were to provide input on the programme and projects supporting their onward development and knowledge mobilisation. Project team leads provide updates during regular oversight meetings for the Research Programmes. Overall, the RSAB was perceived as functional, with every member bringing a different perspective to it and being free to comment on topics of interest based on their specific areas of interest or expertise.

The programme also had a Young Person's Advisory Group, with representatives at the RSAB. The Young Person's Advisory Group included young people with relevant lived experience and ensured that their lived experiences were central to the research. However, the involvement of young people in the RSAB stopped in 2022 when all funding calls were complete, at which point the programme decided to review its approach to how young people could most effectively and meaningfully be involved in its activities.

Most interviewees felt that it was too early to comment on whether the programme's intersectoral design contributed to a wider intersectoral ecosystem change but multiple interviewees described several examples of how the programme is contributing to enhanced or novel ways of working.

The programme is generally perceived as fostering enhanced collaboration. This includes examples of councils working together in a truly collaborative way with real intention. The involvement of different government departments, particularly the MoJ, is seen as important. From a funding perspective, while the programme may not introduce entirely new methods, interviewees felt they have more freedom of operation in its delivery. This includes thinking creatively, adopting a more holistic approach, and having the space to step outside of traditional remits. The Programme Director's role is considered crucial in facilitating these new and enhanced ways of collaborating. The Programme Director is also seen as effective in pulling together relevant people and ensuring that all projects generate valuable insights for policy and practice.

Multi- and interdisciplinary approach

In general, the programme's multi- and interdisciplinary research approach is widely viewed as a strength, fostering collaboration between disciplines that often work in silos. Interviewees appreciate the respectful and considered way different approaches are discussed, with the involvement of arts and humanities being particularly valued. Concerns were raised about the challenges of attracting and creating genuinely multi-disciplinary teams, including the arts and humanities and the medical field.

A key aspect of the programme is its multi- and interdisciplinary research approach, bringing together expertise from fields such as medicine, biology, social science, arts, and humanities. The programme also actively involves young people, parents, teachers, and policymakers to maximise its impact and relevance. According to the Bidding template, proposal applications under the Adolescence, Mental Health and the Developing Mind programme

were required to comprise multi-disciplinary teams co-led by investigators with a range of disciplinary expertise and demonstrate end-user engagement and involvement of young people. Given that most interviewees had not been involved with the programme since its planning stage or launch, only one interviewee commented on the proposals, highlighting that the multi- and interdisciplinary research element was communicated early and clearly to potential applicants. Furthermore, review panels were planned to have multi-disciplinary representation of stakeholders and young people. For instance, one panel member brought in a government department's perspective, linking discussions into government's policy priorities. It was also mentioned that the panels involved broad discussions, looking into different multi- and interdisciplinary research elements.

Interviewees were overall positive about the involvement of multiple disciplines, and this was considered a strength of the programme. Involvement of multiple disciplines was considered helpful given that the disciplines involved in the programme historically work in silos. For instance, medical research and social research were considered as working in silos, with the difference between the two disciplines being the emphasis on quantitative versus qualitative methods of data collection and analysis.

However, participants felt that under the Adolescence, Mental Health and the Developing Mind programme, different disciplines are discussed in respectful and considered way. For instance, the ATTUNE project was mentioned as a positive example of combining quantitative and qualitative data and showcasing enhanced opportunities for impact. ATTUNE aims to understand the mechanisms and mental health impacts of adverse childhood experiences (ACEs) to co-design preventative arts and digital interventions. Incorporating different methods and approaches from different disciplines is what makes the programme so unique and complex according to participants. They described the programme as multi-faceted and of great value, having multiple points of connection by involving both creative writers and artists in residence. According to interviewees, without the programme, they never would have had this many different stakeholders in a room together.

Interviewees appreciated that the arts and humanities sector is being embedded at the heart of the programme and valued by the RSAB and Executive Group. Arts and humanities sector representatives felt that their priorities have been truly embedded in the planning and delivery of the programme. Some interviewees also highlighted the importance of involving people with real world insights and lived experience into the programme such as from the charity sector or young people with relevant lived experience. Nonetheless, concerns were also shared around the difficulties around the realities of creating multi-disciplinary project teams covering both arts and humanities and medical research, and the challenges of matching the ambitions of the funders and the realities of the proposals submitted.

The programme shifted its approach over time to reflect changing needs and opportunities at several points:

- COVID-19 knowledge mobilisation awards were set up considering the COVID-19 pandemic to support adolescent mental health in a unique situation.
- Young people prioritised loneliness, issues of sex, gender and ethnicity in the methodological innovation call following learnings from the research programme call.
- A decision was made to devolve knowledge mobilisation funds to the Director rather than run a funding competition.

- The Research Programme call launch was delayed due to the COVID-19 pandemic.

D.2.4. Programme outputs

Quality of proposals and ability to address more complex challenges

Overall, interviewees appreciated the diversity of successful projects but noted that some could involve more stakeholders and better integrate arts and humanities. The programme attracted a broader range of researchers than previous initiatives and enabled funding for co-production, though its ability to address more complex challenges was difficult to assess.

The diversity and content of successful projects including the breadth of different project types was a positive element of the programme. Examples include projects incorporating the development of games, school-based initiatives, and university-focused research. The combination of elements within proposals was also seen as a positive, with interviewees expressing satisfaction with the interdisciplinary aspects which met expectations. Some concerns were mentioned, including the integration of arts and humanities, which sometimes felt like an add-on rather than a core component. Additionally, some projects could benefit from involving a wider range of stakeholders, potentially referring to the breadth and/or diversity of stakeholders involved. Specific projects highlighted as particularly interdisciplinary include ATTUNE, which engages stakeholders from arts and humanities as well as experts from psychiatry and incorporates gaming. Other projects mentioned include RE-STAR, focusing on regulating emotions and strengthening adolescent resilience, and Digital Youth, a project on adolescent mental health and development in the digital world.

When asked about comparable programmes, comparisons were drawn to funding provided by the National Institute for Health and Care Research (NIHR) which targets similar groups. Nevertheless, except for the Adolescence, Mental Health and the Developing Mind, commissioned studies under the NIHR are often of shorter length and less well-funded. Comparisons were also drawn between the Adolescence, Mental Health and the Developing Mind programme and previous research programmes, such as the cross-council interdisciplinary networks, which were perceived as attracting more traditional researchers or disciplines. This was considered gap as the cross-council interdisciplinary networks did not attract applications from researchers/scientists who had not already been previously engaged in similar projects, such as engineers or computer scientists.

Most interviewees felt it was difficult to comment on whether the multi- and interdisciplinary nature of the programme allowed it to address more complex and multi-faceted challenges than would normally be the case.

Dissemination activities, stakeholder engagement and emerging outputs

As the programme is ongoing until 2026 and interviews took place in May 2025, it is too early to fully assess outputs. In terms of outputs so far, interviewees cited training materials, interventions, and digital tools. Dissemination plans include engaging young people in research. Awareness of dissemination activities varied, but events and policy engagement were noted. Challenges remain around stakeholder engagement and knowledge mobilisation.

Interviewees provided information on various dissemination activities and stakeholder engagement as well as first insights and findings emerging from the different projects. The

input from the National Children's Bureau was considered particularly helpful with regards to dissemination planning. This includes tailored dissemination approaches for different end-users. It was felt that what makes the programme unique and complex is investing in the lived experiences of young people (including people from minoritised backgrounds) by involving them in the research and co-production along every stage of the projects. Young people are, for instance, listed as authors on publications. The projects also have strong social media presence such as own LinkedIn accounts for dissemination purposes which is led by young people as well (for instance, see the LinkedIn account of ATTUNE[20] or the website of Digital Youth[21]).

The programme includes a series of dissemination events tailored to stakeholders as well as further related activities, as mentioned by interviewees, such as:

- Policy event: Organised between project teams and policymakers. Provided learnings from engaging with policymakers (including relevant 'moments' in policy and how scientists should pitch their work) and fostered strong relationships.
- Knowledge Sharing and Networking Conference: Took place in November 2024 and aimed at sharing findings from the methodology projects.

Some concerns were also mentioned around stakeholder engagement. For instance, one key takeaway from the most recent RSAB meeting was that exploitation of relevant stakeholder groups by projects could be improved. However, the final programme conference was expected to provide sufficient opportunities for this. Most of the funded projects under the programme focus on preventative elements in their research which requires the involvement of a wide range of stakeholders, cutting across, for instance, policymakers/government departments and stakeholders such as charities and schools. Therefore, each project faces different challenges concerning the different stakeholder engagement.

Overall, participants referenced the following different types of outputs: Training materials, guidance documents, new interventions (such as clinical and psychological interventions), digital tools (such as games for intervention and assessment purposes), assessments and questionnaires, podcasts and films, toolkits for schools, and research papers. Interviewees appeared to have different definitions of outputs as some had the impression that there are no outputs yet given the ongoing nature of the programme (while others provided examples of project-level outputs).

D.2.5. Programme outcomes and impact - R&I to address priorities

Usefulness, relevance and uptake of outputs

Respondents anticipate concrete and useful outputs, with policymakers already showing interest, particularly in final insights and utility for policy. While some expressed concerns about the uptake of outputs, the programme is expected to produce helpful resources, and there is hope it will inspire young people to pursue research careers, fostering trust in research

20 https://www.linkedin.com/company/attune-project/
21 https://digitalyouth.ac.uk/

institutions. Interviewees generally agreed that adolescent mental health remains a government priority, aligning with various government policies and missions, even those launched after the programme's development.

Many interviewees shared their expectations of outputs as well as what they would find most interesting, relevant, and useful. Overall, interviewees were very optimistic about getting concrete results in programme outputs. Policymakers interest in the findings was also highlighted. Given the busy schedules of policymakers, final insights were considered most important to policymakers, and some were interested in how to best utilise study outputs for further dissemination and consider the utility of outputs for the government department they work for.

It was also flagged that the outputs and findings are not just there for policymakers to access, but an emphasis should also be placed on the strategic and operational relevance of those findings. Insights on novel approaches and methods concerning data collection in the space of adolescent mental health was also considered crucial, particularly concerning how to work with and involve underrepresented groups in research in an appropriate and more sustainable way. The upskilling of young people involved in the programme (the training as 'co-researchers') was referenced, with the idea to have research emerge as a new career option for these young people. More specifically, it was hoped that the programme's insights and outputs can help better communicate the benefits of these approaches to other relevant stakeholders.

Most interviewees did not feel able to comment on the quality of the potential (and to some extent already emerging) outputs and findings of both the programme and individual projects given their limited number, because many of the projects are still ongoing, however one interviewee said that the outputs are of high quality, and co-production with young people has been high.

Likewise, most interviewees felt that it was too early to speak about the uptake and implementation of outputs by end-users as well as wider programme outcomes and impact, because many of the projects are ongoing. The programme's broad scope was considered positive and with high potential for creating value. As the focus of the programme was on mechanistic insight which aims to strengthen the evidence base and which will have broad potential for impact, the impacts are not fully expected to be realised within the lifetime of the programme.

Concerns were also expressed regarding the applicability of research. Whilst current findings go beyond academia and some have practical implications, the uptake of outputs would require additional funding to be implemented in practice and/or more widely.

On the one hand, concerns were raised on the general costs and effectiveness of implementing interventions for youth mental health. There is some caution regarding the costs of delivering interventions and the extent to which they are useful and successful.

On the other hand, positive feedback was raised about outputs successfully informing policy and practice. Some interviewees noted that insights from the projects and the overall programme were helpful in drafting briefings to ministers (such as around social media and the use of mobile phones by young people), raising awareness of ongoing research, and informing best practices for supporting young people – even if those studies have not been fully completed yet. The programme is producing toolkits, guidance, and evidence pieces

that have fed or feed into the DfE around an overall best practice on supporting young people.

Moreover, positive comments were made around engaging young people in research. The programme is seen as a positive example of involving young people in research beyond just asking questions in interviews and surveys. This approach aims to build a pipeline of interested young people, potentially increasing trust in research and related institutions.

Overall, interviewees agreed that adolescence mental health continues to be a government priority and that the programme aligns with government policies, including those introduced after the development of the programme. Various interviewees referenced government priorities or missions that the Adolescence, Mental Health and the Developing Mind programme aligns with. For instance, the programme was considered being cross-cutting in nature, aligning with both DHSC and DfE priorities, such as 'An NHS fit for the future' (including tackling NHS waiting times), 'Safer Streets', and 'Break Down Barriers to Opportunity' (which interviewees felt includes thinking about the impact of mental health and breaking the cycle of young people being held back in life and education).

Wider relevant government priorities mentioned by interviewees include belonging, mental health at schools, eating disorders, loneliness, online harm (and the wider digital environment). In addition, interviewees said the programme was relevant to the educational environment in schools or universities.

A core element of the programme relevant to the needs of the DfE was being able to ensure that young people are able to participate in the education system. This has various knock-on effects that will benefit the wider society such as receiving better grades, being able to get a job, having a higher income, and needing less support later in life. This is further linked to the government's productivity goals. The programme has huge potential in the longer-term as the insights can feed into supporting young people at different stages and in different contexts. In general, it provides avenues for scaling up mental health support across the board.

D.2.6. Programme outcomes and impact – ecosystem change

Interviewees shared what has worked well and what has worked less well, challenges they have faced and overcome as well as lessons learnt concerning intersectoral working (e.g., ways of working, collaborating between partners), supporting and encouraging multi- and interdisciplinary research, and helping to address government R&I priorities. Overall, interviewees had mixed reflections on the programme: Intersectoral working and leadership under the Programme Director were seen as positive, but challenges included resourcing, establishing a common language, and dedicating time to knowledge mobilisation. Incorporating lived experiences and integrating arts and humanities worked well, but challenges arose with data sharing, reaching different researchers, and involving relevant people due to time constraints. Sustainability and putting outputs into practice were concerns, due to the length of time of the programme. Lessons learnt included the importance of co-production and data management planning. Addressing government priorities was challenging due to changing priorities and the need for stronger policy buy-in and early involvement of government departments.

Intersectoral working as part of the collaboration between councils and leadership under the Programme Director appears to have worked well according to interviewees, with the

Programme Director providing visibility of the programme. However, it was mentioned that appropriate resourcing – given the scale of this programme – is a challenge and that the workload and time commitment was not factored into resourcing – i.e. the Project Manager. Programme Manager and Programme Director roles were not costed for the entire duration of the Programme. Rethinking the model of the Programme Director was suggested, including more time and resources allocated to this role. This would allow the Programme Director to tackle the challenging tasks of the programme and achieve better outcomes. A key lesson was the importance of dedicating sufficient resources and time to knowledge mobilisation. Dissemination elements such as promoting insights emerging from projects requires significant effort by individuals involved in the programme. Another challenge mentioned is around finding a common language across disciplines. However, council representatives had fruitful internal conversations on what they mean when they use certain terminology (such as what they mean by 'mechanisms').

Interviewees shared examples of what has worked well with regards to **multi- and interdisciplinary research**, including the representation of arts and humanities and social sciences. Most interviewees spoke positively about the integration of arts and humanities into the programme, with one interviewee describing it as being at the heart of the programme and recognised throughout. It was highlighted that the programme will be able to demonstrate both robustness via the use of legitimate methods used in arts and humanities. The respectful way the different disciplines and approaches have been discussed throughout the delivery of the programme was also emphasised.

However, there were also numerous challenges regarding working within multi- and interdisciplinary research. Notably, multiple interviewees described challenges in finding the right language and facing language barriers when working across different disciplines. Some felt this meant that it was not always practical to have experts from all disciplines sitting together. Moreover, time constraints for people working in the third sector as well as frontline responders meant that it was difficult to identify and involve them. Another challenge mentioned was data sharing and ethics agreements between different organisations.

Concerns were also raised around next steps for the various projects and interventions. This includes concerns around the sustainability of project outputs, particularly digital tools, highlighting the need to bridge the gap between creation and long-term maintenance through sustainability strategies and commercial investment at the programme's conclusion. Translating outputs into practical applications is also a concern, as it requires additional funding for intervention development, with policy impact expected to materialise later. Significant learnings were derived from the approach to co-production with young people. Finally, it was recommended that proposals incorporate a data management approach to streamline delivery and save time.

When it comes to **addressing government R&I priorities**, the programme clearly aligns with a range of government priorities and so far, included opportunities for councils and researchers to engage with and better understand policymakers. However, interviewees shared some challenges around understanding government priorities and using the same terminology. For instance, government priorities and language used around Saving the NHS changed over time making it difficult to use the appropriate examples from the programme to showcase how it is relevant to government priorities. There were also difficulties in tailoring language to policymakers as there was no single set of policies the programme related to. Concerns were

also shared around capturing the longer-term impact of the programme on young people, including whether longer-term funding would be available and the programme interventions are able to deliver at scale.

Lessons learnt include that it is helpful to involve different government departments early on during programme development rather than towards the end of the programme. This included engaging policymakers as the programme is being developed and integrating regular sense-check points throughout delivery. The need for stronger policy buy-in from government departments was also highlighted, for instance in the form of sponsors who commit to outcomes. Another lesson learnt includes the significance of speaking the language of stakeholders and using tailored terminology. For instance, tailoring communications to policymakers was recommended with a focus on the practical implications of the research, as well as possible limitations and areas of caution.

Impacts beyond the programme

Overall, interviewees suggested that the programme has significantly improved relationships across partnering councils, fostering closer collaboration and idea exchange. The positive experience with the Programme Director in this programme has inspired a similar leadership role in a new research programme. Furthermore, the programme's Patient and Public Involvement and Engagement (PPIE) aspects have influenced practices beyond the programme, serving as a case study within UKRI. The Programme Director has also improved researchers' understanding of government R&I priorities. The programme's multi- and interdisciplinary nature has encouraged a shift towards involving all disciplines in mental health research.

Interviewees provided examples of how relationships, communication mechanisms/structures or ways of working between programme teams have changed due to the programme. Programme delivery and development led to improved relationships across the partnering councils. This included working more closely together and collaborating more regularly to exchange ideas and plan future projects together. The SPF mechanisms and ways of working also influenced the development of a new research programme across councils. For instance, the positive role of the Programme Director in the Adolescence, Mental Health and the Developing Mind programme inspired the new programme to adopt similar leadership structure.

Another programme follow on collaboration is the 'Mental Health Platform' which funds the establishment of multi- and interdisciplinary mental health hubs, focused on severe mental illness. The hubs also provide opportunities for crossovers between ECRs and project teams of the Adolescence, Mental Health and the Developing Mind programme.

Furthermore, a current UKRI/Wellcome Trust commission (funded through the AMHDM programme) involves drawing on lived experiences which build on some of the insights emerging from the SPF programme. Finally, aspects of the PPIE have translated beyond the programme, having shared learning around the programme's public partner strategy internally at MRC and more widely within UKRI as a good practice case study[5].

Lessons learnt about encouraging multi- and interdisciplinary research *beyond* the programme, show that the Adolescence, Mental Health and the Developing Mind programme, with its multi- and interdisciplinary nature, has contributed to a shift towards ensuring that all relevant disciplines are involved in discussions, particularly in mental health

research, moving away from a single-discipline approach. Furthermore, the programme has changed and informed how mental health research should be conducted, emphasising the strength of an interdisciplinary approach and learning with young people.

Given the ongoing nature of the Adolescence, Mental Health and the Developing Mind programme, there were limited reflections on whether the understanding of government R&I priorities had improved amongst different people involved in the programme. One participant mentioned that the understanding of government R&I priorities has improved amongst researchers, particularly because of the role of the Programme Director. In addition, the input from members of various government departments on the RSAB was considered to be helpful for funders. As a result, government priorities are more at the forefront of the discussion agenda.

D.2.7. The future

Even though no direct funding has been secured post programme duration, it is expected that outputs and project findings will be crucial for further work in the space of adolescent mental health, and some individual projects have secured follow on funding. The planning of any new funding calls will be dependent on governmental budget decisions. The programme will be live until March 2026, and various programme activities are still underway, including another RSAB meeting later in 2025 and the development of a communication plan (via the National Children's Bureau and the Programme Director). A final conference will also take place, and will consist of a two-day event, presenting an opportunity to showcase impact case studies as well as creative outputs such as animations and other artwork.

D.2.8. Summary and reflections

The Adolescence, Mental Health and the Developing Mind programme has broadened participation beyond traditional disciplines, embedded co-production with young people, and generated early outputs such as toolkits, interventions, digital resources, measures, and training materials. Policy engagement is maturing, with insights informing briefings and DfE practice. The programme aligns closely with DHSC and DfE priorities and contributes to longer-term goals around education participation and productivity. Challenges include uneven depth of disciplinary integration (particularly concerning arts and humanities), capacity constraints for knowledge mobilisation, difficulties establishing shared language and data/ethics agreements, stakeholder time pressures, and uncertainty about sustaining digital tools and scaling interventions without follow-on funding. Shifting policy language also complicates translation.

Key lessons for future work are to dedicate sufficient resources and time to knowledge mobilisation and programme leadership; address language and terminology differences across disciplines early; plan data sharing and management up front to streamline delivery; continue to embed co-production with young people and lived experience; engage government departments earlier with stronger policy buy-in, clear sponsors, and regular sense-checks; tailor communication to policymakers' language with clear practical implications and limitations; and plan for the sustainability and maintenance of outputs – including potential commercial investment and additional funding for implementation – so that promising tools and interventions can be carried into practice beyond the life of the programme.

D.2.9. Stakeholders interviewed

Interviews for the final SPF evaluation were conducted in 2025 with:

- Penny Morton, MRC
- Laura Sibley, MRC
- Robert Tew, MRC
- Josie McGregor, AHRC
- Evie Parmenter, ESRC
- Alaster Smith, DfE
- Alison Tingle, DHSC
- Gill Attrill, MoJ
- Karen Brakspear, MRC

The case study also builds on desk research and 7 interviews with programme leads and wider stakeholders conducted for the Interim evaluation report produced in 2022.

D.3. Bacterial Plant Diseases

SPF Wave 1	SPF funding amount: £17.7 m	Programme Start and end date 01/10/2018 - 31/03/2024 * COVID-19 led to some delays until 2024.
Lead Council / PSRE: BBSRC	Other Council / PSRE: NERC	Government departments: DEFRA and Scottish Government
Key objectives • To deliver research that addresses threats to UK plant health and biosecurity from bacterial diseases.		
Main phases • Phase 1: a £5M integrated body of research on *Xylella fastidiosa* by a consortium of institutions led by the John Innes Centre. • Phase 2: an open managed-mode call for multidisciplinary studies of a range of bacterial pathogens and their interactions with host plants, invertebrate vectors and wider ecosystems.		

D.3.1. Summary

Phase 1 of the Bacterial Plant Diseases programme concluded in 2023, while Phase 2 was completed in March 2024 following delays caused by the COVID-19 pandemic. Lockdowns significantly disrupted fieldwork and slowed progress across most projects, but the research has finished and yielded important outcomes.

The programme's Programme Management Group recognises that it helped to broaden collaboration within the plant health community by funding high-quality, multi- and interdisciplinary research (MIDRI) projects. Compared to other UKRI calls, SPF funding is seen by those who engaged in the final programme evaluation interviews as having fostered deeper partnerships, particularly among disciplines like biological and environmental sciences, where strong collaborative foundations already existed.

Given the serious threat bacterial plant diseases pose to food production, the economy, and the natural environment, the programme aligns closely with government priorities. It has generated vital knowledge not only on how to prepare for a potential outbreak of *Xylella* in the UK but also on other bacterial pathogens (many spread by insect vectors) that impact both agriculture and ecosystems.

D.3.2. Introduction

The growing spread and increased frequency of bacterial plant diseases because of climate change and the global movement of potentially contaminated materials through international trade has become a major concern for plant health in the UK. These pathogens,

along with some of the invertebrate vectors that transmit them, pose serious threats to agriculture, forestry, commercial and ornamental horticulture, woodlands, and broader biodiversity. Their impact extends beyond plants, affecting both rural and urban landscapes with far-reaching economic, environmental, and societal consequences which are aligned with core government priorities, including DEFRA's Plant Health Strategy[22] and the UK Industrial Strategy's Clean Growth and Life Sciences missions.[23]

Bacterial phytopathogens, which cause a wide range of plant diseases, were known to spread via air, soil, or invertebrates, but the specifics of their transmission routes remained poorly understood. The invasive nature of plant diseases, broad host range, and slow-developing symptoms made them especially challenging to control with conventional chemical treatments.

The Bacterial Plant Diseases programme was designed to expand scientific understanding and applied research in plant health and biosecurity. Its goal focused on knowledge generation addressing the complex challenges posed by bacterial infections affecting crops, forests, and other plant systems. This was in addition to engaging and shaping policy in the area of plant health and security. For instance, the programme supported the delivery of government priorities on biosecurity and agricultural resilience, contributing to evidence underpinning DEFRA's strategic objectives.[24] It was jointly supported by BBSRC and NERC, in collaboration with DEFRA and the Scottish Government, and structured across two phases.

Phase 1 (2018/19–2021/22) was launched as a rapid response to the emerging threat of *Xylella fastidiosa*—a highly infectious plant bacterium with a broad host range that had already caused severe damage to olive crops in parts of Europe. Due to the urgency of the situation and SPF funding constraints requiring rapid spend, the research was directly commissioned by the funders and led by researchers at the John Innes Centre. This phase has now concluded, ending in 2024, with the final report submitted and results and outcomes disseminated through academic publications, policy briefings, a research summary flyer and videos.[25]

Phase 2 (2019/20–2022/24) was conducted through an open call for multidisciplinary research exploring various bacterial pathogens. It focused on their biology, epidemiology, interactions with plant hosts, vectors, and the broader environment. However, progress was significantly hindered by the COVID-19 pandemic. Although originally scheduled to begin in April 2020,

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[22] Defra Plant Biosecurity Strategy: https://www.gov.uk/government/publications/plant-biosecurity-strategy-for-great-britain-2023-to-2028/plant-biosecurity-strategy-for-great-britain-2023-to-2028

[23] Industrial Strategy: https://www.gov.uk/government/collections/the-uks-modern-industrial-strategy-2025

[24] https://www.gov.uk/government/publications/plant-health-research-and-development-plan-2023-to-2028/plant-health-research-and-development-plan#:~:text=In%202023%2C%20Defra%20%2C%20together%20with,ensure%20preparedness%20for%20the%20future

[25] Bacterial Plant Diseases publications webpage: https://bacterialplantdiseases.uk/publications/

most projects could not start until September or October 2020, and further disruptions occurred during the January 2021 lockdown.

Given the seasonal nature of plant growth and the timing of critical fieldwork, particularly in spring and summer, some research teams lost two full seasons of field activity in 2020 and 2021. As a result, the projects were granted no-cost extensions and all projects had completed their research activities by March 2024.

D.3.3. Programme Design and Delivery

Intersectoral working and collaboration

The programme had a Programme Management Group comprising BBSRC, NERC, DEFRA, and the Scottish Government. They met regularly in the early stages of the programme's design and implementation but later they met less frequently because there were fewer issues to discuss, and many aspects could be handled by correspondence. Other collaboration mechanisms noted by participants included the overarching steering group, as well as knowledge exchange opportunities (e.g. stakeholder workshops, sharing tasks across researchers of different disciplines, early career training, and master classes on impact).

BBSRC, NERC, DEFRA and Scottish Government had an extensive record of working together before SPF so it was expected that the funders would build on their previous experience to deliver this programme. Overall, the recipients of funding appreciated that the SPF allowed them to continue fostering intersectoral collaboration and maintain the multi- and interdisciplinary (MIDRI) approach that had been part of their strategic agenda for over two decades. As the majority of participants commented, this is largely due to how the SPF orientated the funding call as opposed to other funders and calls. For instance, having a broad thematic call on bacterial plant diseases covering the following funding objectives:

- fund research to understand the threats to plant health from bacterial diseases
- address the needs of policymakers and stakeholders
- increase capability and capacity for research on bacterial diseases

The programme was theme focused and thereby fostered and encouraged collaborative working practices (understanding a problem from different perspectives, plant and human related). The programme's themes and objectives also directly support government R&I priorities on biosecurity, plant resilience, and evidence-based policymaking.[26]

Partners also encompassed multiple disciplines, such as social scientists, and biologists. In May 2019, the second phase of this initiative under SPF was launched through an open call for proposals from BBSRC. The aims were to:

i) support research into the risks posed by bacterial plant diseases,
ii) provide evidence to inform policy decisions and meet stakeholder needs,
iii) strengthen research capabilities and infrastructure related to bacterial diseases.

[26] Plant Research and Development Plan: https://www.gov.uk/government/publications/plant-health-research-and-development-plan-2023-to-2028/plant-health-research-and-development-plan

Multi- and inter-disciplinary approach

The Bacterial Plant Diseases programme was built on a robust partnership between the biological and environmental sciences, reflected in both the funded research and management structure through the involvement of BBSRC and NERC. These two disciplines have a long-standing history of collaboration, given the complex, overlapping issues they often address. The programme also brings in expertise from social sciences, engineering, mathematics, and computational sciences, particularly in areas like diagnostics and modelling. Additionally, several projects incorporate chemistry and geography, highlighting the diverse range of disciplines needed to tackle the multifaceted challenges the programme aims to address, supporting cultural shifts in research engagement and aligning with DEFRA's public awareness and biosecurity priorities.[27]

Phase 2 of the programme supported a multi- and interdisciplinary approach from the start. For instance, it required that the submitted proposals bring together researchers from different disciplines to address the issues outlined in the call for proposals. In addition, the composition of the panel that evaluated the proposals was multidisciplinary and members were briefed about the importance of this approach.

Changing needs and opportunities

The challenges that the programme addresses are associated with prevention against long-term threats. One challenge highlighted by partners was the impacts of COVID-19 on the fieldwork and data collection, as well as on forming alternative approaches to collaboration and knowledge exchange. For instance, most of the meetings, workshops and networking sessions were held online.

D.3.4. Programme Outputs

Phase 1 of the programme led to the creation of the BRIGIT (Surveillance and Response Capacity for *Xylella fastidiosa*) website. This platform brings together a diverse array of resources about *Xylella*, catering to a wide audience. These range from educational materials like a music video and video guides on identifying insect vectors, to webinar recordings presenting key project findings to funders. Information gathered from the programme fed into DEFRA's plant health portal, equipping them with valuable insights should *Xylella* emerge in the UK. As shown, a contingency plan has now been created, demonstrating how programme outputs directly inform policy readiness and long-term preparedness.

A standout element of the *Xylella* project was its 'citizen science' component, aimed at engaging families and communities. The project recognised that individual behaviours, such as purchasing infected ornamental plants, can contribute to the spread of pests and diseases. Raising public awareness through accessible materials – including videos,

[27] Defra's Plant Health and Research Development Plan: https://www.gov.uk/government/publications/plant-health-research-and-development-plan-2023-to-2028/plant-health-research-and-development-plan#:~:text=In%202023%2C%20Defra%20%2C%20together%20with,ensure%20preparedness%20for%20the%20future

information sheets, infographics and a protocol for reporting symptoms to the TreeAlert service – helps the public, including children, identify plant symptoms, encouraging cultural shifts in community engagement with research and prevention practices.[28]

In Phase 2, the programme was able to attract high quality proposals but in smaller number than expected due to the tight funding timeline set by the SPF, which allowed limited flexibility in budget use. The Programme Management Group also noted that the programme's governance and reporting requirements were more intensive compared to other UKRI-funded projects.

While it is still early for definitive outcomes, the programme has already fostered a shared knowledge base and common language among stakeholders, and funders expressed a strong interest in sustaining these collaborative relationships, ensuring continuity and long-term impact of programme knowledge.

D.3.5. Programme outcomes and impact - R&I to address priorities

In Phase 1, which focused on the *Xylella* disease, several key outputs addressed the challenges identified during the programme's design. A protocol for analysing *Xylella* samples was developed for use if the disease ever reaches the UK. Multiple government designated laboratories are now set up to use this BRIGIT protocol, ensuring consistent and comparable results. The project also gathered data on plant trade routes within the UK and examined the factors influencing decisions made by stakeholders such as importers, nurseries, buyers, and schools. This insight can help policy-makers target interventions more effectively to limit the spread of plant diseases. In addition, the programme deepened understanding of *Xylella's* biology, including how its insect vector behaves across different regions and temperatures, the times of year it is most active and dangerous, and how symptoms manifest in plants. All findings have been compiled into a final report shared with funders. While the outputs have not yet been deployed—since *Xylella* has not entered the UK—they have significantly strengthened government preparedness should an outbreak occur. For instance, the UK government has implemented stringent measures to protect its plant health, including increased restrictions on importing high-risk host plants. This includes tighter controls on olive trees and other plants susceptible to the disease, such as coffee, almond, lavender, oleander, and rosemary. These measures aim to reduce the risk of *Xylella* entering Great Britain via imported plants.

In Phase 2, two projects investigated acute oak decline, a major disease causing significant loss of mature oaks. They explored how environmental factors affect the trees and how the disease progresses. This knowledge is vital for shaping policies to manage and prevent its spread, given oak's importance across ecosystems, landscapes and industries. Stakeholders noted that it is still too early to determine the full uptake of project outputs within Phase 2. One stakeholder noted that there have been knowledge exchange activities, with a final dissemination activity occurring in March 2025.

It was also agreed that the projects delivered in Phase 2 were closely aligned to the government's research and innovation priorities. A key success factor mentioned was the

[28] Tree Alert Service: https://treealert.forestresearch.gov.uk/

collaborative involvement of Defra and the Scottish Government who were instrumental to shaping programme design and delivery. Their inputs were particularly helpful throughout the visioning and design stages of the programme. Feedback provided during steering committee meetings was also perceived as of critical importance for programme delivery. This aligns with the UK Government's R&D People and Culture Strategy which emphasises cross-disciplinary collaboration and the development of research networks to address complex societal challenges.[29]

D.3.6. Programme outcomes and impact – ecosystem change

Multiple stakeholders and partners felt that there was a research community change brought by the programme. For instance, collaboration patterns were identified after the programme, bringing together experts from different disciplines. Interviewees felt that this was driven by the funding theme and criteria set out for multi and interdisciplinary working. One participant noted that partners from the project still engaged in conversations and discussed new topic areas, especially across biosciences and social science disciplines. For this reason, stakeholders felt interdisciplinary and intersectoral working was at the core of their projects.

However, there was no evidence of radical structural change brought about by the funding, as some participants felt that university departments already foster MIDRI behaviour. Nevertheless, with SPF funding, project leads were able to bring together an array of researchers from different disciplines and sectors, which had a transformative effect in terms of connecting people and capturing good quality research outputs.

The SPF funding shaped the process of collaborative working and contributed to the development of more holistic research findings. For instance, the funding helped understand the threat of *Xylella fastidiosa* in the EU and showed how this could impact wider economic and social systems in the UK. It further helped link scientific evidence to the development of relevant policy recommendations.

In practice this required:

- teams to exchange perspectives when planning the future direction of a project,
- structuring teams to work closely together across disciplines on work packages (biosciences and social scientists),
- building in communication mechanisms within the different work packages (e.g., workshops and meetings), as well as amongst the project coordinators and leadership team.

Only one participant noted that even though partners were engaged for the purposes of the research, this collaboration will not last beyond the project duration or translate into cross-disciplinary learnings.

In terms of intersectoral working, the Programme Management Group reported that this programme was supported by government partners throughout its duration to provide guidance. Despite the impacts of COVID-19, having online meetings, workshops and

[29] R&D strategy: https://www.gov.uk/government/publications/research-and-development-rd-people-and-culture-strategy

networking sessions made the process successful. Although there was a preference for in-person working, online collaboration was seen as beneficial for all partners, Research Councils and government organisations.

In terms of the MIDRI approach, funders and partners felt that the importance of involving different disciplines to develop a wider understanding of real problems was central to the programme's structure and design. For instance, one respondent noted that MIDRI working seemed like a challenge at first due to the time required to learn new terminology and understand different research approaches. However, involvement by government and programmes' leadership team, as well as adopting a research challenge-led approach, helped mitigate these challenges.

Programme activities seen as particularly helpful included a series of visioning workshops during the early programme design phase, and feedback provided from the Programme Management Group. With support from the SPF, a programme's Coordination Team was assembled to tackle the issue from multiple angles, enabling stakeholders to actively exchange strategic information. The funding enabled them to apply this shared knowledge in practice. For instance, a delay was needed due to the fieldwork seasons of beetle larvae, but this provided an opportunity for the social scientists to gain further understanding of the biologists' working practices.

D.3.7. The Future

One of the main programme outcomes was that the fund brought together a community of researchers from different sectors and disciplines to be trained in the area of bacterial plant diseases. As a result of bringing these different disciplines and skillsets together, the programme developed an understanding of new diagnostics, new ways of treating plant diseases, how new technologies can support the development of more resilient plants, mitigations in the environment, among other issues. In addition, it is expected that research publications will continue to emerge, along with other forms of knowledge exchange activities, such as conference presentations and spin out companies. Multiple publications have already emerged and can be found on the main programme website.[30] These activities will lead to a better understanding of how bacterial plant diseases spread and what change in behaviours we can engage with to avoid it.

These outcomes directly support the UK Industrial Strategy, particularly its Life Sciences and Clean Growth missions, by enhancing the UK's capability to respond to biosecurity risks, develop innovative plant health solutions, and strengthen the resilience of agricultural and environmental systems. The programme's cross-sector collaboration and knowledge exchange also align with the Industrial Strategy's emphasis on building networks of expertise to address complex societal challenges.[31]

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[30] John Innes Centre Publications webpage: https://www.jic.ac.uk/research-impact/publications/

[31] UK Industrial Strategy: https://assets.publishing.service.gov.uk/media/68595e56db8e139f95652dc6/industrial_strategy_policy_paper.pdf

However, it is important to note that some industry and government participants had moved on to different projects and had not been involved in the creation of scientific outputs from the programme highlighting potential challenges for sustaining collaboration beyond the project duration (sustainability) and scaling outputs to wider industry or policy applications (scalability). This suggests that while SPF funding can successfully convene expertise and generate knowledge, additional mechanisms may be needed to maintain engagement and ensure longer-term impact.

D.3.8. Summary and reflections

The Bacterial Plant Diseases programme was jointly led by BBSRC, NERC, DEFRA, and the Scottish Government, building on long-standing intersectoral collaboration. Early Programme Management Group meetings transitioned to online correspondence as processes matured. Steering groups, workshops, and knowledge exchange activities supported collaboration across funders, researchers, and policymakers.

The programme integrated biological, environmental, and social sciences, alongside engineering and computational sciences, to address complex plant disease challenges. Phase 2 required proposals to be multidisciplinary, with evaluation panels supporting cross-disciplinary collaboration. This MIDRI approach fostered a shared knowledge base, a common language, and stronger research networks.

The first phase of the programme developed the BRIGIT platform and a national testing protocol, which was adopted by government laboratories. It engaged the public through citizen science initiatives such as TreeAlert reporting and educational materials, and gathered data on plant trade routes to inform policy interventions.

The second phase projects were aligned with government priorities, strengthening the evidence base for disease management and policy development. Collaboration was maintained despite Covid-19 restrictions and tight funding timelines.

Overall, the programme strengthened cross-disciplinary and intersectoral collaboration, enhancing national preparedness for plant diseases. Outputs are expected to continue to emerge, and include publications, conferences, diagnostics, and management innovations, contributing to a lasting research community. Programme efforts provide a stronger evidence base for future policy on plant health. They will help government and wider stakeholders make informed decisions, improve disease management strategies, and respond more effectively to emerging threats.

D.3.9. Stakeholders interviewed

The participants included for the final SPF evaluation in March-April 2025 are:

- Mariella Marzano, Programme Coordination Team Lead, Forest Research
- Denise A'Hara, Scottish Government, SASA,
- Jef Grainger, Senior Responsible Officer, BBSRC
- Clare Trivedi, Government Department Partner, DEFRA
- Weihao Zhong, Research Council Partner, NERC
- Debbie Harding, Programme Lead, BBSRC

The case study also builds on desk research and 5 interviews with programme leads and wider stakeholders conducted for the Interim evaluation report produced in 2022.

D.4. Clean Air

SPF Wave 1&2	SPF funding amount: £42.5 m	Programme Start and end date 15/10/2018 - 31/03/2025
Lead Council / PSRE: NERC and Met Office	Other Council / PSRE: EPSRC, ESRC, IUK, MRC, NPL	Government departments: Defra, DfT, DHSC, Scottish Government, Welsh government
Key objectives • Drive forward new multidisciplinary research and innovation • Leverage existing UK investments and enable a challenge-focused multidisciplinary community to work together • Inform implementation of the UK government's Clean Air Strategy • Develop new solutions to reduce emissions of atmospheric pollution • Present information to stakeholders and the public • Build a new UK interdisciplinary community at the interface of indoor/outdoor air quality emissions, exposure and health impacts.		
Main phases • Wave 1: Clean Air: Analysis and Solutions programme • Wave 2: Clean Air: Future Challenges		

D.4.1. Summary

Strategic Design and Delivery: The programme's two-phase approach enabled strong foundational scoping followed by targeted, interdisciplinary implementation, aligning with national R&I priorities.

Intersectoral Collaboration: Clean Air broke down silos, fostering collaboration between academia, government, local authorities, and industry. Structures like Clean Air Champions and stakeholder networks were central to this shift.

Embedding Interdisciplinary Research (MIDRI): MIDRI became a defining feature, with tailored funding, assessment, and training mechanisms. However, early integration of social sciences remains an area for improvement.

Real-World Policy and Practice Impacts: Research outputs directly shaped local and national air quality policies, supported public engagement, and informed health and environmental interventions.

Systemic and Cultural Change: The programme initiated lasting change in how environmental R&I is conducted, funded, and applied—though sustaining these changes will require further investment and institutional ownership.

Emerging Legacy and Influence: Clean Air's models have influenced other UKRI programmes and international initiatives. Its legacy depends on securing ongoing support to maintain momentum.

D.4.2. Introduction

The Clean Air Programme, part of the UK's Strategic Priorities Fund (SPF), was established to address the persistent and complex challenge of air pollution through interdisciplinary research and cross-sector collaboration. Its aim is to harness expertise across academia, government, and industry to generate innovative research, build long-term partnerships, and deliver solutions aligned with national research and innovation (R&I) priorities.

The programme was designed with a two-phase structure. Phase 1 (2018–2019) focused on scoping existing knowledge, identifying research gaps, and establishing early networks through scoping studies and stakeholder engagement. This phase laid the groundwork for more integrated and targeted activity. Phase 2, launched in 2019, marked full-scale implementation, with large-scale interdisciplinary research projects funded to explore the health, environmental, and social dimensions of air quality. Partnerships in this phase included key institutions such as the Met Office, enabling the integration of metrological science into wider frameworks of environmental and policy research.

The programme is reportedly progressing well, with the strategic awarding of grants stimulating high-quality research and fostering collaborations across sectors. Notably, while formal funding for some partners such as the Met Office has concluded, organisations like National Physical Laboratory (NPL) have remained actively involved, demonstrating sustained commitment through continued coordination activities, including organising the final programme event. This ongoing engagement underscores the programme's legacy in supporting enduring interdisciplinary networks and policy-relevant knowledge exchange.

As this case study will demonstrate, the Clean Air Programme exemplifies how coordinated public investment can drive innovation, shape evidence-based policymaking, and contribute to the UK government's broader R&I agenda. Its phased design, interdisciplinary approach, and sustained collaboration offer a compelling model for addressing complex environmental and public health challenges. Although the programmes were established under the previous Conservative government, the topic of Clean Air remains relevant at the time of writing (2025) for the subsequent Labour administration. Air quality remains a strong focus as demonstrated by the newly proposed Clean Air (Human Rights) Bill introduced in July 2025 aiming to give the Office for Environmental Protection (OEP) more powers in future.[32]

D.4.3. Programme Design and Delivery

Intersectoral working and collaboration

Clean Air unites a diverse array of stakeholders, including local authorities, Defra, the Met Office, Public Sector Research Establishments (PSREs), academia, industry, and more, in a concerted effort to combat pollution through an integrative strategy. Its governance framework is structured around diverse steering committees that ensure alignment of strategic activities across sectors, creating a well-coordinated network that enhances both programme delivery and policy execution. These collaborative efforts are further bolstered by networks like the "Clean Air Community" and initiatives such as the Clean Air Champions, which play a

[32] https://bills.parliament.uk/bills/3998.

pivotal role in bridging sectoral divides, promoting resource sharing, and facilitating strategic planning among various stakeholders.

Clean Air Champions serve as facilitators of collaboration by connecting diverse research teams and ensuring insights and methodologies are shared across disciplines. They act as intermediaries between the academic community and external stakeholders, translating research findings into practical applications and policy recommendations. Moreover, the Champions are instrumental in organising events and workshops to promote ongoing dialogue and knowledge dissemination. Their network, comprised of experts from fields such as environmental science, health sciences, engineering, and social sciences, enhances the programme's integration and overall effectiveness, ensuring that the Clean Air Programme's research aligns with societal and policy goals and results in tangible, real-world impacts.

The programme leverages digital platforms used to facilitate regular communication and collaboration among stakeholders, including those from government, industry, and academia. Workshops serve as venues for presenting research findings, discussing new ideas and methodologies, and refining strategies to tackle air quality challenges. They also focus on fostering interdisciplinary collaborations by bringing together diverse expertise to generate innovative solutions. They are attended by a wide range of participants, including researchers from different disciplines, policymakers, industry representatives, and community stakeholders. Despite reported challenges such as limited engagement from the Department for Transport (DfT), which highlights areas for improvement, the initiative sets a benchmark for future collaborative efforts aimed at enhancing air quality and public health in line with the UK's research and innovation goals.

Before the programme's implementation, efforts to address air quality were often fragmented, with limited collaboration between crucial sectors. The initiative has successfully transformed these isolated attempts into robust, intersectoral networks, significantly improving cooperation between previously siloed domains such as health and the environment. This transformation has led to the development of new partnerships among academia, industry, local authorities, and charities, marking a significant cultural shift towards integrated efforts to address air quality issues.

By fostering strong partnerships with critical departments like the Department of Health and Social Care (DHSC) and The UK Health Security Agency (UKHSA), the programme not only addresses present needs but sets the foundation for ongoing and future collaborations. Moreover, the governance process is continuously enhanced through diverse engagements that break down silos, though there is still room for growth by involving local government and the Health and Safety Executive more comprehensively. Incorporating social sciences and economics has broadened the programme's perspective, offering a more comprehensive understanding of air quality impacts.

Additionally, the phased "wave" approach adopted by the programme has reportedly been instrumental in refining collaborative methods and promoting an environment favourable to cross-sector collaboration. This adaptive framework not only furthers scientific inquiry but also ensures the programme's ongoing relevance and efficacy in addressing evolving air quality and public health concerns.

Multi- and Inter- Disciplinary Research & Innovation (MIDRI)

The Clean Air Programme has significantly propelled the integration of multiple disciplines through its MIDRI approach, breaking traditional boundaries and uniting fields like engineering, health, environmental science, social sciences, and economics to address air quality challenges. Interdisciplinary collaboration is indeed a core strength of Clean Air, particularly among atmospheric sciences and health research, which has enriched the research landscape and brought about coordinated innovation. This is evidenced by the programme's

success in bridging gaps between traditionally siloed disciplines, encouraging novel collaborations and partnerships such as those between toxicologists and environmental scientists, and facilitating impactful projects like pioneering cohort studies on indoor air pollution. By mandating MIDRI as a criterion for proposal eligibility, the programme has developed robust collaborative frameworks, further fostering a cohesive interdisciplinary community.

After a notable conference took place under the Clean Air programme, several projects that successfully combined different disciplines came together in a conference with participants from over 38 other projects. This gathering was an opportunity for them to share insights, present their research findings, and build networks for future collaboration opportunities. Despite these successes, challenges remain in integrating multiple disciplines right from the onset of project's inception periods. Initially, projects may predominantly focus on fields like environmental science or engineering, with disciplines such as social sciences and economics being incorporated later in the process during the delivery of projects. This sequential inclusion can limit the interdisciplinary depth that could be achieved if all relevant fields were engaged from the outset. Engaging social sciences early on is crucial because issues like public compliance with air quality measures often hinge on understanding societal behaviour and economic impacts.

To assess MIDRI proposals more effectively, the programme has established diverse assessment panels covering a wide range of disciplines, ensuring comprehensive evaluations that appreciate interdisciplinary approaches. Holistic evaluation criteria that included proposals assessed not only on their scientific and technical merits but also on their ability to integrate multiple disciplines effectively. This intent strategically aligns assessments with the programme's interdisciplinary goals. Specialised training for panel members and feedback mechanisms for applicants enhance this process, ensuring that proposals effectively meet MIDRI objectives.

The programme's adaptability is demonstrated by its ability to shift priorities over time. For example, programme focus was moved from foundational research to a strong emphasis on indoor air quality, reflecting significant health implications including respiratory problems, asthma exacerbation, and potentially long-term cardiovascular and neurological effects. This shift aligns with broader understandings among researchers and policymakers of integrating indoor and outdoor air quality as part of a comprehensive strategy. The programme also adapts to technological changes and societal needs, expanding its focus to alternative fuels and increasingly recognised pollution factors like tyre and brake wear. Increased public engagement and the integration of health considerations have strengthened programme initiatives, supported by interdisciplinary collaboration and strategic partnerships with local governments, NGOs, and industry. These shifts and feedback-driven strategies ensure the programme remains responsive, significant, and impactful in both scientific and policy domains, underscoring its strategic agility.

While some projects utilised art installations to effectively communicate scientific findings to the public, the arts were not as embedded into the programme as other disciplines. In response, the Clean Air Champions are exploring ways to better integrate the arts into the programme through workshops or roundtables, in collaboration with the Arts and Humanities Research Council. This initiative aims to develop recommendations on how the arts can be included in future programmes, highlighting the potential benefits of doing so for enhanced public engagement and communication. This effort represents a forward-thinking approach to creating a more inclusive and comprehensive interdisciplinary network within the Clean Air Programme.

D.4.4. Programme Outputs

The Clean Air Programme has consistently attracted high- MIDRI proposals due to its robust funding and well-coordinated research framework. Its large scale and focus on air quality have drawn wide-ranging interests and facilitated collaborations across disciplines that might not have formed otherwise.

This unique platform for multidisciplinary collaboration plays a vital role in addressing complex air quality challenges effectively.

Such cross-disciplinary efforts have led to practical innovations that combine technical expertise with behavioural insight. A case in point is the Aerlusiv project, led by Applied Nanodetectors, which serves as a strong example of interdisciplinary technological innovation. The system employs highly sensitive nano sensors, capable of detecting up to sixteen gases at extremely low concentrations and uses AI to interpret data and generate timely alerts.[33] By bringing together engineering, atmospheric science, and behavioural insight, Aerlusive not only advances home-based air quality monitoring but also reflects the Clean Air Programme's emphasis on user engagement and cross-disciplinary collaboration.[34]

Over the past five years, the programme has funded over 38 diverse projects, establishing a distinct research identity and facilitating significant interdisciplinary collaboration. By promoting research networks that bring together experts from different fields, the programme effectively targets complex air pollution issues such as the intertwined health impacts of air quality, the role of building design and ventilation on pollution dispersion, and the comprehensive economic and social factors involved in implementing air quality solutions.

One such project within the programme that has directly contributed to new technologies that address indoor pollution in practical, user-friendly ways is KluraLabs (formerly CodiKoat), with the development of CodiVent - an innovative air filter that utilises nanoparticle array technology to eliminate over 99.9% of nitrogen oxides from indoor environments.[35] The project was funded through the Clean Air Programme via a Small Business Research Initiative (SBRI) competition led by I-UK, which sought practical solutions to improve indoor air quality in domestic settings. Designed to be retrofitted into existing ventilation systems and kitchen hoods, the technology has been trialled in collaboration with manufacturers such as Vent-Axia. CodiVent exemplifies how the Clean Air Programme has successfully supported the translation of cutting-edge scientific research into commercially viable solutions that address critical, underserved sources of indoor pollution.[36]

A further example of innovation supported by the programme is the work of *Immaterial*, a spin-out from the University of Cambridge. The team has developed advanced filtration materials based on metal-organic frameworks (MOFs), which are particularly effective at capturing nitrogen dioxide from indoor air, especially during periods of high pollution. This addresses a

[33] Advanced Nanodetectors (AND). Aerlusive™ – Smarter Home Indoor Air Quality Monitoring System. Found at: https://applied-nanodetectors.com/smarter-home-indoor-air-quality-monitor-system/

[34] Clean Air Programme, 2022. Smarter Home Indoor Air Quality Monitoring System. Found at: https://www.ukcleanair.org/projects/smarter-home-indoor-air-quality-monitoring-system/

[35] Innovate-UK, 2020. Results of Competition: SBRI: Monitor and Visualise Domestic Pollution to Safeguard Health.

[36] Clean Air Programme, 2022. CodiKoat: Harnessing Nanoparticle array technology for the removal of domestic atmospheric pollutants

previously overlooked area of domestic exposure and demonstrates how the programme has created novel applications of materials science within environmental health research.[37]

The streamlined application process and clearly communicated collaboration expectations likely contribute to attracting skilled researchers and fostering an environment conducive to high-quality, interdisciplinary proposals capable of addressing the multifaceted nature of air pollution, cementing the programme's status as a catalyst for interdisciplinary research.

Beyond just technical innovation and multidisciplinary projects, the programme also facilitated outputs that reflected new modes of collaboration across sectors. In addition to generating high-impact technologies and insights, the Clean Air Programme enabled cross-sectoral outputs through its flexible design, which actively encouraged collaboration across industry, academia, and the public sector. This approach allowed projects to move beyond traditional research outputs and deliver practical solutions grounded in real-world needs. An example is the *'Measure, Inform, Nudge'* initiative by arbnco, developed in partnership with the University of Strathclyde and the Glasgow School of Art, and trialled through the government-supported Energy Systems Catapult's Living Lab.[38] This collaboration brought together behavioural science, design, environmental monitoring, and digital innovation to create a user-facing air quality feedback system. The project illustrates how the programme's structure supported the development of outputs that were not only technically robust but also socially and commercially relevant.[39]

Strong community engagement is evident within Clean Air, with the programme's structure (including steering groups, champions, digital platforms, workshops and conferences) allowing participants, even those joining midway, to engage and influence outcomes meaningfully. This widespread engagement evidences the viability of large-scale programmes in uniting academic and industrial sectors. The Clean Air Conference in 2023 underscores the community's strong interest and alignment with the programme's objectives. The event highlighted the extensive range of activities undertaken by the networks and aimed to outline the future directions for indoor and outdoor air quality research and policy as a legacy for the UK Clean Air community. Organised by seven networks funded by the UK Clean Air Strategic Priority Fund, along with SAQN and the UKRI Clean Air Champions, it drew over 200 attendees. These included air quality researchers, policymakers, industry partners, and civic sector groups, representing fields such as atmospheric sciences, health, social sciences, and building sciences.[40]

Compared to typical UKRI programmes, the Clean Air initiative boasts higher multidisciplinary engagement, with 10-15% participation from non-academic sectors, surpassing the usual 1-5%. The structured engagement activities and supportive framework have cemented community responsiveness, highlighting the Clean Air Programme's distinction in promoting a cohesive

[37] UKRI. Platform technology for the removal of critically underserved air pollutants in homes. Found at: https://gtr.ukri.org/projects?ref=10021494

[38] Energy Systems Catapult, 2021. arbnco breezes into air quality market with Living Lab trial. Found at: https://es.catapult.org.uk/news/arbnco-trial-air-quality-in-living-lab/

[39] Clean Air Programme, 2022. Measure, Inform, Nudge: an integrated, human-centric air quality measurement & visualisation system. Found at: https://www.ukcleanair.org/projects/measure-inform-nudge-an-integrated-human-centric-air-quality-measurement-visualisation-system/

[40] SAQN, STFC Air Quality Network. (2023). Clean Air Networks Conference 2023. Available at: https://www.saqn.org/events/clean-air-networks-conference-2023/

interdisciplinary community that actively engages with governmental entities to address air quality issues.

By moving beyond traditional siloed approaches, the Clean Air Programme has successfully integrated disciplines such as atmospheric science, public health, engineering, and social science to offer a systems-level perspective on air quality challenges. This interdisciplinary framework has enabled not only the development of innovative tools and models for high-resolution pollution analysis but also the design of interventions that are socially and culturally responsive.

Although the inclusion of social sciences within the programme was often staggered, this sequencing had important impacts for how socio-economic and behavioural dimensions were integrated into technological research. In the early stages, delayed involvement may have limited opportunities for co-design and reduced the immediacy with which social insights could shape technical priorities. However, as the programme matured, the growing engagement of social scientists enabled a more holistic exploration of socio-economic barriers and societal implications, leading to interventions that were not only technically sound but also equitable and more likely to secure public trust and compliance. Notably, the programme's research has produced robust, real-world datasets and emission models that highlight the causes and impacts of both outdoor and indoor air pollution, particularly for vulnerable populations such as children, older people, and those with pre-existing health conditions. These insights have directly informed comprehensive policy recommendations tailored to regional and national contexts, bridging the gap between academic research and policy application.

Strategic engagement with end-users, including policymakers, public health officials, and industry leaders has been a core strength. Outputs have been delivered in accessible, decision-ready formats, enabling their use in active policy planning and implementation. Mechanisms such as policy roundtables and stakeholder workshops have created iterative feedback loops, ensuring that end-user insights shape both the research agenda and its outputs.

Dissemination efforts have included peer-reviewed publications, public webinars, newsletters, and high-profile conferences, developing a dynamic exchange of knowledge among researchers and practitioners. While stakeholder engagement has been robust, the programme acknowledges the ongoing need to enhance the visibility and uptake of its findings, particularly in sectors where sustained behavioural change or long-term policy shifts are required.

D.4.5. Programme Outcomes and Impact - R&I to Address Priorities

Programme findings have been instrumental in shaping national and local policy. Research directly informed updates to government air quality guidelines, focusing on reducing exposure among vulnerable populations. Local authorities used these outputs to support the introduction of low-emission zones and other targeted pollution control measures, addressing specific regional challenges.

Predictive air dispersion models developed through the programme have been adopted by industry to optimise operations, reduce emissions, and meet new environmental compliance standards. This represents a measurable shift towards more sustainable industrial practices.

Health agencies and community organisations used programme insights to increase public awareness about air pollution and its health risks. This enabled informed behavioural responses, such as ventilation improvements and air purifier use, particularly in households with vulnerable occupants. Early evidence suggests improved health outcomes in urban centres.

There are Clean Air-supported innovations that have bridged the gap between scientific research and user-oriented health technologies. One such example is Nooku (formerly Family Air), which has developed a personalised indoor air quality monitoring system aimed at families with vulnerable individuals, including those living with asthma or COPD.[41] Supported through Innovate UK and piloted in homes across Glasgow with support from Innovate UK. The system utilises IoT-enabled sensors alongside a user-friendly app to provide real-time data and tailored feedback. Beyond its health benefits, Nooku has demonstrated strong commercial potential, with products now stocked by major retailers including Currys, Amazon, and Best Buy. This highlights the Clean Air Programme's ability to support innovations with tangible public health benefits and viable market pathways.[42]

Educational resources and open-access datasets developed under the programme were adopted by schools to raise environmental awareness among children. Public engagement was further supported through webinars, newsletters, and workshops, reaching diverse community groups.

The programme's interdisciplinary model has been cited internationally, informing emerging air quality initiatives and fostering cross-border collaboration on atmospheric and health research.

While early uptake has been encouraging, gaps remain in ensuring consistent and sustainable integration of research outputs into long-term policy and practice. Dissemination, particularly beyond research stakeholders, requires strengthening to improve mainstream adoption. Mechanisms to embed outputs in institutional and policy frameworks are still under development.

The programme successfully aligned with government priorities around public health, environmental protection, and climate resilience. According to interviewees, outputs such as research reports and technical tools and models, reportedly contributed to strengthened regulation of air quality, especially in high-exposure zones, and supported efforts to reduce health inequalities. Tools and evidence have been taken up by local authorities, the NHS, and the education sector to guide strategic decisions and community interventions.

The Clean Air Programme established a new benchmark for integrated environmental research. It catalysed further R&I funding, set standards for interdisciplinary collaboration, and built a foundation for sustained improvements in air quality management. While long-term impacts are still unfolding, the programme has already demonstrated significant influence on policy, practice, and public health — both nationally and internationally.

D.4.6. Programme Outcomes and Impact – Ecosystem Change

There is strong evidence that the Clean Air Programme catalysed ecosystem change across the UK's air quality research and policy environment. These changes are evident in how actors collaborate, how research is conceptualised and funded, and how science is translated into policy and practice. While not all elements of the system were transformed, the programme achieved significant shifts in norms, behaviours, and structures that suggest an emergent, though still fragile, ecosystem-level transformation.

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[41] UKRI. Nooku Health - Improving Noncommunicable Disease Prevention through long-term, personalised Air Quality Monitoring. Found at: https://gtr.ukri.org/projects?ref=10046745

[42] Glasgow City Region. SCSP Innovation Fund Case Study Nooku. Found at: https://glasgowcityregion.co.uk/wp-content/uploads/2025/05/Nooku-FINAL.pdf

The Clean Air Programme successfully established robust intersectoral networks involving academia, government departments (e.g. Defra, DHSC, Met Office), local authorities, industry, and civil society. These networks were sustained by mechanisms such as steering committees, policy roundtables, stakeholder forums, and dissemination events. Importantly, these structures facilitated new norms of interaction between organisations that had previously worked in silos. It was noted that Clean Air facilitated increased trust, stronger communication mechanisms, and an enduring culture of collaboration beyond the programme's immediate lifespan.

A key enabling mechanism was the Clean Air Champions, who provided distributed leadership and served as boundary-spanners—bridging research, policy, and public engagement. This contributed to a shared sense of purpose across diverse actors and gave the programme credibility and visibility across sectors.

However, challenges were noted in early coordination and alignment across institutions with different operational cultures, and in engaging actors beyond the 'usual suspects' in the field. These experiences underline the importance of early-stage co-design and strategic inclusion planning in future programmes.

Innovate UK has played a pivotal role in advancing the clean air innovation ecosystem, not only by supporting individual business successes but also by strengthening the system's overall capacity for sustained impact. Through projects such as Cage and Cool Run, which evolved from feasibility studies to advanced R&D, Innovate UK has demonstrated how targeted funding, and guidance can bridge early-stage innovation to market-ready solutions.

The commercial success of Nuku (formerly Family Air), now available through international retailers such as Currys, Amazon, and Best Buy, further illustrates how commercial uptake is critical to ecosystem resilience - it validates the demand for clean air technologies, attracts further investment, and reinforces the links between innovation, adoption, and policy relevance. By cultivating a network of enterprises within the Clean Air programme, Innovate UK has not only supported technological progress but also brought the conditions necessary for long-term transformation across the sector, including collaboration, credibility, and scalability.

The programme meaningfully advanced MIDRI. It funded projects that integrated natural sciences, health, engineering, and social science—often for the first time in this policy domain. This was supported by tailored funding mechanisms, specific proposal criteria, and inclusive assessment processes that legitimised MIDRI approaches.

These practices led to tangible changes in researcher behaviour and confidence. Early career researchers reported increased interest and skill in interdisciplinary work, while funders observed a rise in high-quality MIDRI applications post-programme. New interdisciplinary centres and doctoral training pathways were established, demonstrating structural shifts in the research ecosystem.

Nevertheless, some systemic barriers remain. Social science was often integrated late in project cycles, and the lack of dedicated long-term funding and appropriate academic incentives were identified as threats to sustaining MIDRI as a norm. Despite these challenges, Clean Air acted as a proof of concept for embedding MIDRI into environmental research programming.

One of the programme's most significant impacts was the improved alignment between scientific research and government R&I priorities. Government departments and councils reported a better understanding of the research landscape, greater confidence in using scientific evidence, and increased capacity to apply tools and insights to real-world problems. Collaborative research activities, co-produced agendas, and mutual horizon scanning contributed to more strategic and responsive policymaking.

Notably, Clean Air helped to institutionalise mechanisms like stakeholder advisory groups and joint research-policy working groups, that made the science-policy interface more durable. For example, Defra's policy and monitoring capabilities have been enhanced by integrating advanced modelling tools developed through the programme into the national Air Quality Monitoring network in collaboration with the Met Office. These high-resolution models provide detailed analyses of pollution patterns and potential regulatory impacts, enabling evidence-based policymaking to enhance environmental health. Furthermore, the programme has influenced critical policy discussions by highlighting the importance of indoor air quality and offering robust evidence on its health impacts, thereby guiding the development of improved standards and interventions.

However, it is important to note that sustained impact requires further investment in 'translation infrastructure' such as policy fellowships, embedded researchers, or funding for post-programme coordination—to maintain momentum.

There is credible evidence of spillover effects from the Clean Air Programme influencing adjacent areas of the research and innovation ecosystem. This includes the adoption of Clean Air's co-creation and engagement models by professional bodies and new programmes; new commercial ventures and public-private partnerships leveraging Clean Air technologies; the uptake of programme design features (e.g., MIDRI criteria, stakeholder involvement) in subsequent UKRI initiatives like the Future Treescapes programme and continued collaborations between programme partners on new challenges (e.g., infectious diseases, climate-related air quality issues).

These legacy effects suggest that Clean Air has not only influenced its immediate stakeholders but also helped shape broader institutional norms and programme design principles across the UK research system.

Despite the programme's successes, ecosystem change remains emergent rather than embedded. Sustaining the networks, behavioural shifts, and research-policy linkages created by Clean Air requires ongoing investment and ownership of shared infrastructure and mechanisms for continuity of tools, data, and relationships. Interviewees cautioned that without further support, the gains made could dissipate. While there is momentum, it is not yet self-sustaining.

Table 5 Summary of the Clean Air programme's key outputs, outcomes and impacts

Theme	**Outputs**	**Outcomes**	**Emerging and realised impacts**
Multi/ Interdisciplinary platform	Two-phased programme with 38+ funded projects; clean air champions; steering groups; assessment panels spanning disciplines; digital collaboration platforms.	10–15% non-academic participation; stronger cross-sector consortia; more and better MIDRI proposals; ECR skills and confidence; social sciences increasingly included (often later).	Cultural shift towards systems thinking; new interdisciplinary centres/pathways; MIDRI design features adopted by other UKRI programmes; need for sustained support flagged.
Technology and	Examples include: Aerlusive nano-sensor + AI alerts (Applied	Pilots/trials (Living Lab, manufacturer trials); retail traction (Nooku	Practical, user-facing indoor air solutions; commercial pathways

commercial innovation	Nanodetectors); CodiVent NOx-removing filter (KluraLabs/CodiKoat) trialled with Vent-Axia; MOF filtration for NO2 (Immaterial); Nooku personalised IAQ system; SBRI/IUK competitions.	with Currys, Amazon, Best Buy); follow-on IUK funding; active SME network in clean air tech.	de-risked; improved exposure management for vulnerable households; UK clean air tech profile strengthened.
Tools, models and datasets	High-resolution emission/dispersion models; robust real-world indoor/outdoor datasets; decision-ready tools and resources.	Adoption by Defra/Met Office national AQ monitoring; used by industry for compliance and optimisation; used by local authorities for LEZs and interventions; schools adopt educational resources.	Evidence-based policy and compliance; better prediction/management of exposure; groundwork for reduced morbidity in high-exposure settings.
Policy engagement and decision support	Policy roundtables; stakeholder workshops; accessible briefs/outputs; co-produced agendas.	Updates to guidance prioritising vulnerable groups; local LEZ design/support; increased policy capacity/confidence to use science.	More responsive, equitable air quality policy; durable science & policy interface practices embedded.
Cross-sector collaboration mechanisms	Clean Air Conference 2023 (200+ attendees across academia, policy, industry, civic sector); seven networks + SAQN; ongoing coordination (e.g., NPL).	Strong, responsive community; new partnerships beyond "usual suspects"; continued engagement beyond formal funding.	Enduring networks and trust; benchmark for intersectoral working in environmental health.
Behavioural and user-centred interventions	'Measure, Inform, Nudge' feedback system (arbnco + partners); arts-based communication pilots; public webinars/newsletters.	Improved public awareness; behaviour change (e.g., ventilation, purifier use), especially in households with vulnerable occupants.	Early signals of improved health outcomes in urban centres; increased citizen agency in exposure reduction.

Focus on vulnerable populations and equity	Datasets and models highlighting exposure and health impacts for children, older people, and those with pre-existing conditions; tailored policy recommendations.	Targeted local/national interventions; integration of health equity in design and evaluation.	Contribution to reduced health inequalities linked to air pollution exposure.
Strategic agility and scope evolution	Shifted emphasis to indoor air quality; attention to alternative fuels and non-exhaust emissions (tyre/brake wear).	Research remains aligned to emerging risks and policy needs; broader stakeholder relevance.	Systems-level perspective on air quality normalised across research and practice communities.
International influence and spillovers	Programme model, co-creation methods and MIDRI criteria cited externally; design elements taken up in other UKRI initiatives.	Cross-border collaboration; replication of engagement and design practices.	UK leadership in integrated air quality R&I; wider institutional norm change.
Translation and sustainability infrastructure (gaps and learning)	Identification of needs: policy fellowships, champions, embedded researchers, post-programme coordination; exploration of arts integration with AHRC; white paper and final impact work.	Clearer pathways for future funding and continuity; plans to deepen arts/public engagement; recognition of DfT engagement gap.	If resourced, more durable embedding of tools, data and relationships; risk of dissipation without continuity mechanisms.

D.4.7. The Future of Clean Air

As the Clean Air Programme reaches its formal conclusion, attention has shifted toward sustaining its momentum, embedding its legacy, and leveraging its successes to support long-term impact. While the programme has laid a strong foundation of interdisciplinary networks, policy-relevant evidence, and collaborative ways of working, there is widespread recognition that sustaining this progress requires deliberate and structured follow-through. Without a clear successor programme or funding stream, there is a risk that the progress made, particularly around intersectoral integration and research-policy alignment, could fragment over time.

Several concrete efforts are underway to extend the programme's influence. A steering board is developing a white paper aimed at securing future investment from UKRI and advocating for continued research into the health impacts of air pollution. The final Clean Air conference and an upcoming impact report are seen as critical moments for consolidating the programme's achievements, strengthening stakeholder relationships, and articulating a case for future funding.

There are also signs of programme legacy being embedded within institutional structures. Follow-on projects have already been funded by Innovate UK, and several research councils plan to lead future initiatives aligned with their remits. For example, the ESRC is expected to advance work on air pollution and public health. In addition, stakeholders are exploring new collaborative structures, including interdisciplinary hubs and a potential permanent Clean Air research network to maintain coordination and knowledge exchange.

Importantly, the programme's influence is expected to persist through its integration into broader UKRI strategic themes such as "Building a Green Future" and through contributions to government "mission" agendas. It has also helped define emerging research frontiers most notably, indoor air quality, as priority areas requiring dedicated ownership and investment, something that was cited as currently underdeveloped.

Nonetheless, there are open debates about where the responsibility for sustaining key tools, datasets, and partnerships lies. Consulted interviewees presented mixed arguments that long-term viability should have been planned from the outset, suggesting that large public programmes have a duty to embed sustainability pathways. Others maintained that it is not the role of time-limited research programmes to operationalise or maintain their outputs, but rather to deliver proof-of-concept innovations for others to pick up. This tension reflects broader questions about how public research investments can be structured to balance innovation with continuity. The debate highlights a structural tension in UKRI's funding model: time-limited programmes incentivise innovation but could potentially risk undermining long-term capacity unless paired with sustainable continuity mechanisms.

Looking ahead, several anticipated outcomes and ambitions signal the future potential of the Clean Air Programme's legacy:

- Continued publication of academic outputs and policy-relevant insights, deepening the evidence base for clean air initiatives.
- Uptake of research findings in areas such as building regulations, ventilation standards, and targeted health interventions.
- Strengthened public engagement and educational activities, including interdisciplinary training opportunities for early-career researchers.
- Increased confidence among funders and researchers to support and pursue multi- and interdisciplinary approaches in related domains.
- Potential development of new funding mechanisms to sustain MIDRI collaborations beyond the environmental sector.

There is widespread agreement that Clean Air should not be seen as an endpoint but rather a stepping stone toward a more coordinated, mission-driven approach to addressing air pollution and environmental health challenges. Consulted stakeholders stressed the importance of embedding the programme's successful practices into future policy, funding, and institutional frameworks.

D.4.8. Summary and reflections

The programme's strategic two-phase approach enabled strong foundational scoping followed by a targeted, interdisciplinary implementation that aligned with national R&I priorities. This design was central to breaking down silos and fostering collaboration between academia, government, local authorities, and industry, with structures like Clean Air Champions and stakeholder networks proving central to this shift.

A feature of the programme was the embedding of interdisciplinary research (MIDRI) through tailored funding, assessment, and training, although early integration of social sciences remains an area for improvement. This approach resulted in real-world policy and practice impacts, as research outputs directly shaped local and national air quality policies, supported public engagement, and informed health and environmental interventions.

Ultimately, the programme set the conditions for systemic and cultural change in how environmental R&I is conducted, funded, and applied. Its emerging legacy and influence on other UKRI programmes and international initiatives now depend on maintain the collaboration mechanisms and institutional ownership to sustain this momentum.

D.4.9. Stakeholders interviewed

Interviews for the final SPF evaluation were conducted in 2025 with:

- Kay Heuser, NERC
- Natasha Soutar, NERC
- Phil Messenger, Met Office
- Michael Lis, Met Office
- Ajinkya Rao, EPSRC
- Ellen Potts, ESRC
- Kevin O'Malley, IUK
- Tom Gardiner, NPL
- Stephen Holgate, University of Southampton
- Gary Fuller, Imperial College London
- Charlotte Hall, DHSC

The case study also builds on desk research and 4 interviews with programme leads and wider stakeholders conducted for the Interim evaluation report produced in 2022.

D.5. Ensuring the Security of Digital Technologies at the Periphery

SPF Wave 1	SPF funding amount: £30.6 million	Programme Start and end date 2018 to 2025
Lead Council / PSRE: EPSRC	Other Council / PSRE: AHRC, ESRC, Innovate UK	Government departments: Government Communications Headquarters (GCHQ), National Cyber Security Centre (NCSC), DCMS, Home Office
Key objectives £30.6 million programme supporting the development of a safe and secure 'Internet of Things' (IoT), particularly to protect more critical applications from sophisticated cyber threats. Within the key objectives were two set of activities: 1) Research / funding calls and 2) Synthesis, outreach and engagement.		

D.5.1. Summary

The Ensuring the Security of Digital Technologies at the Periphery (SDTaP) programme was a £30.6 million initiative aimed at advancing a safe and secure Internet of Things (IoT), with a focus on safeguarding critical applications against complex cyber threats. The SDTaP programme, led by Prof. Jeremy Watson and funded by EPSRC with government and industry support, successfully fostered intersectoral collaboration and interdisciplinary research. The programme used mechanisms such as industry placements, academic partnerships, and public knowledge exchange events. A diverse governing board, including universities, businesses, UKRI and government representatives, and regular meetings provided strategic oversight. The programme brought together engineers, social scientists, and others to address cybersecurity issues around the IoT, encouraging cross-disciplinary understanding. Building on the PETRAS (Privacy, Ethics, Trust, Reliability, Acceptability and Security) network, new initiatives emerged outside of SDTaP like CRANE (Cyber Security Research and Networking Environment) and the Innovation and Knowledge Centre in Northern Ireland. The PETRAS programme generated 436 publication entries, each generating their own research and knowledge exchange impacts to the wider society.

D.5.2. Introduction

SDTaP was a £30.6 million programme aimed at advancing the development of a safe and secure IoT. In particular, the programme supported the protection of critical applications from sophisticated cyber threats. Society is increasingly relying on technologies such as the Internet of Things and Artificial Intelligence to enhance our lifestyles, our goods and services. Finding potential solutions to the challenges that arise from these technologies requires transdisciplinary research done in collaboration with industry and government.

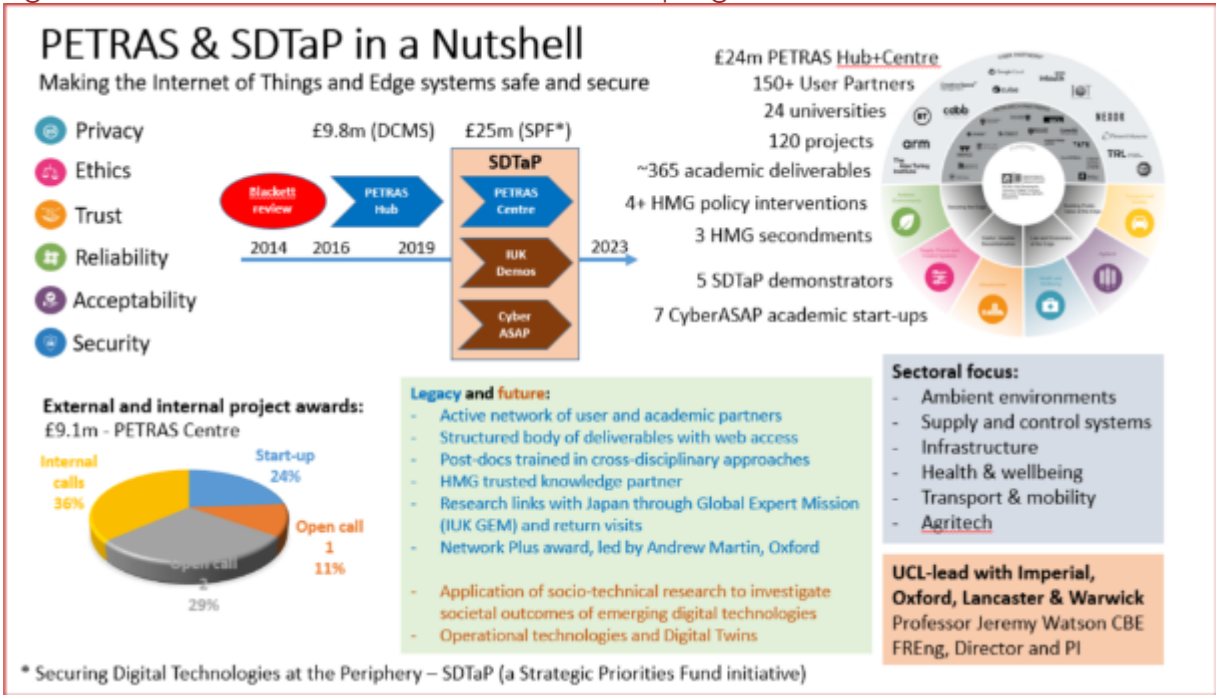
It was funded by EPSRC, AHRC, ESRC and Innovate UK with policy support from DCMS and the Home Office. The overall programme objectives were to deliver:

- A national capability for the coordinated research and development of IoT or cyber solutions at the periphery of the internet.
- A new and strategically meaningful interdisciplinary research and industry collaboration applied to the domain that brings together IoT, artificial intelligence (AI), behavioural psychology and computer engineering.
- A successful world-leading knowledge transfer from the UK research base to UK industry.

The SDTaP programme built on the PETRAS programme. The PETRAS hub was established in 2016, becoming a National Centre of Excellence from 2019 with the SPF funding. The Centre existed to ensure that technological advances in the IoT and systems at the 'edge' of the Internet, were safely and securely developed and applied in consumer and business contexts. This was initially funded in 2016 by DCMS, and later by the SPF from 2019 to 2025 both through EPSRC.

A visual overview of these two projects (PETRAS and SDTaP) was developed by the SDTaP, Prof, Jeremy Watson (University College London), and is available below.

Figure 3 An overview of the PETRAS and SDTaP programme structure



Source: © Prof. Jeremy Watson, UCL

D.5.3. Programme design and delivery

Design

Overall, SDTaP had four project elements, outlined below.

1. ***PETRAS National Centre of Excellence***

PETRAS was originally established in 2016 and funded as part of the IoTUK programme run by DCMS. Funding for IoTUK ended in 2019. However, the majority of participants noted that PETRAS developed an internationally recognised brand and reputation as a high-profile UK

asset. For example, it fed into the development of the Secure by Design GOV.UK guidance[43], which in turn informed the development of international standards on IoT cyber security. It originally involved 16 universities and secured around £14 million in cash and in-kind investment from partners. By the end of the programme, the number of universities involved grew to 23, and around 150+ user partners. As part of SDTaP, PETRAS is a National Centre of Excellence (NCE) for IoT systems' cyber security. The SDTaP programme invested £13.85 million into the PETRAS NCE over five years between January 2019 and September 2023. This investment was the main element of the SDTaP programme, along with the Innovate UK demonstrators. It included 23 universities and engaged with more than 120 partners. The PETRAS NCE has awarded over £9 million in internal and external opportunities since being set up.

2. ***Innovate UK demonstrators***

The demonstrators were large-scale industry-led projects to deploy, test and experiment with nearer-to-market ideas focusing on addressing major IoT cyber security challenges. Projects were offered funding over two rounds. For more information about the funding call for demonstrator projects visit the website.[44] These demonstrators directly supported the UK Government's Industrial Strategy and its mission to strengthen the digital economy through innovative technologies and cyber resilience.[45]

3. ***Innovate UK commercialisation programme***

There was a strand of the Cyber Security Academic Startup Accelerator Programme (CyberASAP), which aimed to identify any promising commercial opportunities coming out of PETRAS-funded research and offered commercialisation support for those promising innovation potential and societal impact. Now in its eighth year, CyberASAP provides academics with the expertise, knowledge and training needed to convert their research into technologies, products and services in this key sector of the global economy. The programme creates a pipeline to move great cyber security ideas out of the university lab and into the commercial market. This aligns with government R&I priorities outlined in the UK Digital Strategy 2025[46] and the National Cyber Strategy[47] by supporting the growth of secure, innovative digital infrastructure and encouraging private sector uptake of cutting-edge technologies.

4. ***EPSRC research grants***

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[43] Secure by Design guidance: https://www.security.gov.uk/policy-and-guidance/secure-by-design/

[44] Call for demonstrator projects: https://apply-for-innovation-funding.service.gov.uk/competition/544/overview

[45] Industrial Strategy: https://www.gov.uk/government/collections/the-uks-modern-industrial-strategy-2025

[46] UK Digital Development Strategy: https://assets.publishing.service.gov.uk/media/6613e7f7c4c84d4b31346a68/FCDO-Digital-Development-Strategy-2024-2030.pdf

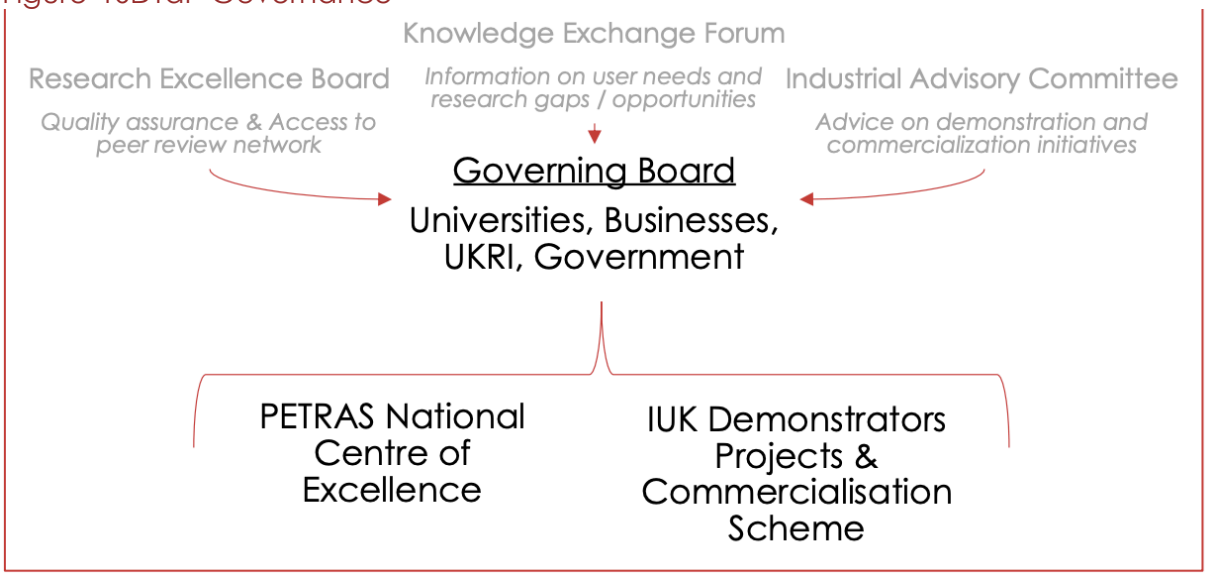
[47] UK National Cyber Strategy 2022: https://www.gov.uk/government/publications/national-cyber-strategy-2022/national-cyber-security-strategy-2022

Three EPSRC research grants were awarded through the SDTaP programme. These projects were: Trust in human-machine partnership (Fostering trust in this technology requires the technology to be transparent), AutoTrust (designed to be a human-centred trusted, secure, intelligent, and usable internet of vehicles), and VeTSpec (verified trustworthy software specification). These grants were part of the overall SDTaP Strategic Priorities Fund, which focused on cybersecurity at the edge of the internet. This investment supports government missions to ensure safe adoption of AI and IoT technologies as described in the National AI Strategy and the Industrial Strategy's priority on advanced digital technologies. [48]

Intersectoral working and collaboration

The SDTAP programme involves four UKRI Councils (EPSRC, AHRC, ESRC and IUK), two government departments (DCMS and the Home Office) and a consortium of universities and other institutions that are part of the Privacy, Ethics, Trust, Reliability, Acceptability and Security National Centre of Excellence for IoT Systems Cybersecurity (PETRAS). PETRAS has a group of five universities that are part of the senior management team, called the quintet.

Figure 4SDTaP Governance



The SPF-funded programme built on the pre-existing PETRAS centre. Therefore, PETRAS got ~£14m of the ~£30m that SDTaP received and is heavily involved with the programme operation. IUK is another council that gives considerable input, through its demonstration and commercialisation programme, and received £11m. The rest of the SPF funding supported three research grants and fellowship projects which were related to IoT and consequently of interest for SDTaP, and numerous small grants for start-up businesses.

The SDTaP programme was funded by EPSRC with support from partners (AHRC, ESRC, GCHQ/NCSC). Multiple stakeholders noted that the Principal Investigator (PI - Prof. Jeremy Watson from UCL) played an important role in pulling all the strands together and fostering networking within the programme team. According to them, this was due to his previous experience and knowledge acquired whilst working as a Chief Advisor within the

[48] UK's National AI Strategy: https://www.gov.uk/government/publications/national-ai-strategy

Government, as well as within industry prior to academia. This experience provided him with the necessary insight into the strategic priorities of different sectors, such as technology industry and government policy. Using this insight, the PI was able to steer the project with a "bigger picture oversight", understand the full scope of a situation, including its wider context, potential impacts, and long-term consequences.

Various mechanisms instilled into the working practices of the programme to foster effective intersectoral working and collaboration were also mentioned. This involved offering academics opportunities for industry work experience, fostering partnerships between industry and academic institutions within each project, organising public and knowledge exchange events (such as those at Tate Modern), and establishing an inclusive programme guided by an independent governing board.

The Industrial Advisory Committee independent board included policymakers, industry representatives, lawyers and funders. This board included members from universities, businesses, UKRI, and government departments—such as Chief Scientific Officers—and was led by an independent chair from a major private sector organisation. The board met twice a year to guide the overall direction of the work and ensure activities aligned with the mission and proper processes.

A smaller group, made up of the SDTaP core team and UKRI representatives, met monthly to review progress and keep the work on track. They provided regular strategic guidance and oversight. The PI also emphasised the importance of creating opportunities for communication and knowledge exchange across all partners throughout the programme. This included collaborative work with the Department for Transport (DfT) for 18 months. For instance, findings from the SDTaP programme were utilised to create policy measures for the effective use of smart sensors to monitor traffic. Another example was the research team's visit to Japan, showcasing the learnings from both PETRAS and SDTaP. During this event, Prof Jeremy Watson met with Chief Technology Officer of Hong Kong police after giving a talk at IET conference in Hong Kong and its relevance for their society.

Cross collaborations across the different sectors (policy decision-makers, technology industry, academia, etc.) and disciplines (social sciences, engineers, economists, etc.) were noted by all participants to work well. This was helped by the fact that partners had previously worked together on the PETRAS programme which had established a pre-existing network. Furthermore, one partner felt that there was a pre-existing ecosystem of collaboration in place and the programme helped to additionally foster this. Similarly, some participants felt the role of SDTaP in expanding the network of specialists, led to the creation of the CRANE initiative which is a UKRI-funded network focused on building and nurturing a robust cyber security research ecosystem in the UK. This network aims to bring together key people from across academia and industry to work in the best way to better protect us against cyber threats and attacks. The UKRI investment underlines the network's commitment to enhancing the UK's security and resilience, ensuring that we are prepared to adapt to the evolving challenges of the digital world. Another project building on the SDTaP work is the Innovation and Knowledge Centre in Northern Ireland.

Multi- and Interdisciplinary (MIDRI) Approach

Programme participants noted the interdisciplinary nature of the programme and the role of the PI in bringing researchers together to tackle common problems, as well as in selecting multidisciplinary projects to be sponsored by the fund. For example, the CyberASAP

programme under the SDTaP Programme benefited from the experience and specialist knowledge of an extensive network of practitioners (including in New Product Development, Innovation Planning, Sales, Investment, Pitching, Communications). Similarly, the SDTaP programme encouraged multiple disciplines (social sciences, engineers, economists, etc.) to consider the issues of Privacy, Ethics, Trust, Reliability, Acceptability and Security as they relate to IoT devices, systems and networks. This approach reflects the Industrial Strategy's emphasis on collaborative R&I and creating the conditions for a globally competitive digital sector.

There were key lessons learnt from the interdisciplinary approach used in the delivery of the programme. One of these, was the PI's encouragement to foster events and ensure that researchers from different disciplines take the time to familiarise themselves with each other's expert terminology and research approaches. This occurred both in the form of early career events, and whilst working closely on different research projects. Another lesson learnt, was that the programme team had selected the right people who proactively encouraged knowledge sharing activities, created an inclusive environment for working collaboratively, and created a legacy database.[49]

It is noteworthy that whilst overall, the project retained the core objectives and goals, adjustments were made during COVID-19. For example, some of the key communication activities were moved online (via Zoom or Microsoft Teams) as opposed to in person. In person knowledge exchange activities (in-person meetings and events) featured later in the programme delivery once COVID-19 restrictions reduced.

D.5.4. Programme outputs, outcomes and impact – R&I to address priorities

The programme has been able to continue to attract high quality MIDRI projects with the help of SPF funding. PETRAS evaluates the final reports and decides what can be published out of that work and more than 600 papers have been published so far for both the PETRAS and SDTaP programmes collectively. They identify the work of being of the highest quality, and 85-90% of the projects have been concluded until now. In addition, all the projects have been assessed, and the successful ones were sent to the Advisory Board, composed of various experts across academia, industry, and government, for their approval.

Example programme outputs include:

- The establishment of the four synthesiser fellows, academics who worked across the projects to identify what is the common learning and what could be fed into government policy or practice in industry. They were responsible for collating and disseminating findings from studies to the programme partners, including industry and government. They organised the online legacy database of all research outputs, which are now available on PETRAS website, and are the ones who set up the knowledge exchange events described above.
- Policy recommendations have already been published by research originated from SDTaP. Synthesiser fellows submitted these to potential decision-makers in government.

[49] PETRAS legacy website: https://petras.cs.ucl.ac.uk/petraspublications/

Multiple stakeholders felt that the research undertaken as part of the programme aligned with government priorities. The involvement of DCMS and the Home Office throughout programme delivery was mentioned as particularly helpful to foster this alignment. Examples included selecting projects which involve multiple sector partners, organising collaborative meetings between stakeholders, and government departments being invited to sit on the independent governing board.

Also, the PETRAS National Centre of Excellence for IoT Systems Cybersecurity supported the Information Commissioner's Office (ICO), contributing to the 2022 Tech Horizons Report.[50] The programme researchers provided knowledge based on research findings for the report and explored the implications of some of the most significant technological developments for privacy before 2030. To do that, the report focused on the following four technologies: consumer healthtech; next-generation Internet of Things (IoT); immersive technology; and decentralised finance.

In addition, participants noted that local governments also benefited from PETRAS's insights, particularly in adopting IoT and edge technologies. Its dedication to societal impact included public engagement through exhibitions, events, and a podcast series at a regional level. However, with future policy priorities moving forward rapidly, particularly within the cyber security space, more funding opportunities are required to build on the SDTaP's learnings and outcomes.

All stakeholders consulted found the research outputs to be of a high quality and relevant to end users. However, it is not certain how many of the outputs have already been used by wider stakeholders. For example, the PETRAS project generated 436 publication entries, each with their own research and knowledge exchange impacts to the wider society (e.g., insights have influenced government policies, informed policymaking on cybersecurity, and fostered public engagement through various outreach efforts).

The PETRAS's[51] own website recorded a similar number of publication entries – 356, with many of the publications having citations over 10. One suggestion from some stakeholders was to examine any relating short-term outcomes in order to discover long-term impacts.

Finally, the importance of keeping the momentum beyond the programme timeline was highlighted. Future activity is required to ensure that the programme learnings can be implemented, with concerns that there could be duplication of knowledge created otherwise. Some suggestions were to create an alumni event or similar showcase of programme findings.

D.5.5. Programme outcomes and impact – ecosystem change

Programme stakeholders felt that there was an ecosystem change during the programme's lifespan and the programme significantly contributed to that change alongside other factors within the wider policy and research context. SDTaP brought together different stakeholders across an array of sectors and disciplines, who in turn were successful in formulating new

[50] Future Tech Report: https://ico.org.uk/media2/about-the-ico/documents/4023338/ico-future-tech-report-20221214.pdf

[51] PETRAS resources database: https://petras.cs.ucl.ac.uk/petraspublications/

knowledge in the cybersecurity space. The most commonly referred to example was the collaborative work between SDTaP researchers and the DfT which spanned 18 months and resulted in DfT using programme findings to create policy measures for the effective use of smart sensors to monitor traffic.

Programme partners mentioned some initial challenges limiting intersectoral working at the onset of the programme. For instance, the COVID-19 pandemic limited in-person communication in the first months of the programme, even though participants managed to adjust and rapidly adopt online communication channels. This also included using an interconnected approach across the different projects to ensure industry, policy and academic perspectives are all taken into account. Conversely, the shift to online communication during the COVID-19 pandemic enabled greater adaptability and fostered more interconnected collaboration across industry, policy, and academia, and may have accelerated digital collaboration in ways that benefitted the programme overall.

Another practice which fostered intersectoral working was using an open communication and knowledge exchange strategy, such as ensuring that emerging lessons and findings are known by all those engaged in the programme. For instance, all resources and learning from the programme are freely accessible from the PETRAS resources database.[52]

Under the Standards, Government and Policy workstream of the programme, partners worked closely with the Department for Digital, Culture, Media and Sport (DCMS) to support the development of the Code of Practice for Consumer IoT Security, providing a review of existing standards, best practices and international avenues suitable for managing IoT security in a globally coordinated manner. Researchers from the PETRAS programme also worked closely with the IoT-1 Committee of the British Standards Institution (BSI) to inform the development of standards for IoT security, privacy and interoperability, and to understand the needs and concerns of SMEs operating in the IoT space.[53]

D.5.6. The Future

In the future, it is anticipated that SDTaP's work on cybersecurity will continue through different grant schemes. The programme's main lead, Jeremy Watson has recently retired, but the work will be carried on by other programme partners. Academics have acknowledged that the research impact will take time to filter through, with programme publications and research outputs still being released. This aligns with the UK Government's National Cyber Security Strategy, which emphasizes the importance of building long-term cyber capabilities and ensuring the sustainability of research-informed cybersecurity initiatives. The PETRAS legacy database (see footnote below) exemplified how the Centre functions as an enduring platform, providing open access to research findings and

[52] PETRAS resources database: https://petras.cs.ucl.ac.uk/petraspublications/

[53] PETRAS Stream Report: https: //efaidnbmnnnibpcajpcglclefindmkaj/https://s3-eu-west-1.amazonaws.com/uclpetras/wp-content/uploads/2019/10/28144344/PETRAS-Stream-Report.pdf

knowledge for the wider community, and will continue to be maintained in 2025 to ensure sustainability and accessibility of its outputs.[54]

One participant noted that moving forward industry and government stakeholders may prefer to see programme impacts sooner. This in turn could generate a culture shift in how future research funding is distributed in a way similar to the current system in the US. For instance, future funding calls could be more oriented towards the UK industry sector as opposed to academia. However, another participant highlighted that the PETRAS programme demonstrated to funders that academics could deliver a programme to a high standard, tackling real-world challenges in cyber security.

Furthermore, it was acknowledged that within the timeframe of the SPF funding, it is unrealistic to expect changes in policies or laws as a result of the programme. It is hoped that there will be future policy changes in cyber security in the long-term as a legacy from SDTaP, as well as any knowledge generated by future programmes in the field of cybersecurity.

Stakeholders emphasised the importance of continuity beyond the SPF funding period. It is hoped that there will be more involvement and contribution from UKRI (e.g., further funding calls and research consortiums created) in developing a long-term funding strategy.

D.5.7. Summary and reflections

The SDTaP programme supported industry-led IoT cybersecurity demonstrators, EPSRC research grants, and the CyberASAP commercialisation programme, helping move academic research to market. Total funding of approximately £30 million included £14 million for PETRAS, £11 million for Innovate UK demonstrators, and smaller grants for research and start-ups.

The programme involved four UKRI councils (EPSRC, AHRC, ESRC, Innovate UK), government departments including DCMS and the Home Office, and the PETRAS National Centre of Excellence. Principal Investigator Prof. Jeremy Watson played a key role in integrating sectors and disciplines. Collaboration was encouraged through industry placements, knowledge exchange events, advisory boards, and inclusive programme governance.

Projects brought together social sciences, engineering, economics, and computing. CyberASAP and research grants promoted cross-sector learning and early-career interdisciplinary training. Adaptations during COVID included online communication and knowledge exchange.

The programme produced over 600 published papers, and synthesiser fellows collated findings for government and industry. It influenced policy through contributions to the DCMS Code of Practice for Consumer IoT Security and DfT smart sensor policies. Resources and research outputs are maintained in the PETRAS legacy database for public access.

The programme strengthened the UK cybersecurity research ecosystem through CRANE and other networks. Its legacy is expected to continue through publications, collaborations, and

[54] UK's National Cyber Security Strategy: https://www.gov.uk/government/publications/national-cyber-strategy-2022/national-cyber-security-strategy-2022

future UKRI funding, supporting both policy development and industrial uptake. These outputs provide a stronger evidence base for future policy on IoT security, helping government and industry make informed decisions and respond effectively to emerging cybersecurity challenges.

D.5.8. Stakeholders interviewed

The participants interviewed for the final SPF evaluation in March-May 2025 are:

- Mark Gaskarth, EPSRC
- Jeremy Watson, University College London
- Wendy Hall, University of Southampton
- Bronwyn Jones, Edinburgh University
- Charles Morisset, Newcastle University

The case study also builds on desk research and 7 interviews with programme leads and wider stakeholders conducted for the Interim evaluation report produced in 2022.

D.6. Modern Slavery and Human Rights Policy and Evidence Centre

SPF Wave 2	**SPF funding amount**: £10 m	**Programme Start and end date** Initial programme: 01/09/2019 - 31/03/2024; Continuation phase: 01/04/2024 - 31/03/2027
Lead Council / PSRE: AHRC	**Other Council / PSRE**: ESRC	**Government departments**: Home Office Ministry of Justice

In the initial programme, the Centre was hosted by the British Institute of International and Comparative Law (BIICL);
In the continuation phase the Centre is being hosted by the University of Oxford, Humanities Division.

Other partners in the initial programme:

- The Bingham Centre for the Rule of Law (British Institute of International and Comparative Law)
- The Rights Lab (University of Nottingham)
- The Wilberforce Institute (University of Hull)
- The Centre for the Study of International Slavery (University of Liverpool)
- The Bonavero Institute of Human Rights (University of Oxford)
- The Alan Turing Institute

Other partners in the continuation phase:

- The Bingham Centre for the Rule of Law (British Institute of International and Comparative Law)
- The Wilberforce Institute (University of Hull)
- The Centre for the Study of International Slavery (University of Liverpool)
- The Bonavero Institute of Human Rights (University of Oxford)

Key objectives

A focus on policy impact by bringing together academics, policymakers, businesses, civil society and survivors to collaborate on addressing the complex legal and policy related challenges of modern slavery. The programme's vision has been to achieve this goal through pursuing the following outcomes:

- Policymakers, lawmakers, businesses and practitioners increasingly know about, access and understand evidence and analysis
- Policymakers, lawmakers, businesses and practitioners increasingly use evidence in their work.
- A portfolio of high-quality research informs and fills gaps in evidence and knowledge, and produces evidence-based recommendations.
- More powerful insights into the expertise and perspectives of people with lived experience of modern slavery is embedded into research, policies, practice and laws
- Collaboration is amplified in research and policy to more effectively address modern slavery.

- The MS PEC's research during its Initial Programme phase was based around four pillars: survivor support and recovery; prevention; supply chains; and legal enforcement measures.

Examples of programme calls

- Addressing modern slavery with data science methods.
- Modern slavery and climate change.
- Support for children with lived experience of modern slavery.
- Prevention of modern slavery.
- Effectiveness of interventions to prevent modern slavery.

D.6.1. Summary

The Modern Slavery and Human Rights Policy and Evidence Centre (MS PEC) initiative brings together a wide range of stakeholders—academics, government officials, businesses, civil society groups, and people and communities with lived experience of modern slavery — within the UK, aiming to tackle the global issue of modern slavery. The MS PEC programme has made significant strides in fostering intersectoral collaboration and embedding inclusive practices in modern slavery research. It established strong governance structures, such as the Senior Management Board and Advisory Board, and engaged consistently with government departments, particularly the Home Office. Engagement with people with lived experience (PWLE) and third-sector voices has enhanced the relevance and impact of its work. The programme's multi- and interdisciplinary (MIDRI) approach brought together diverse academic disciplines and non-academic partners through equitable funding models and participatory proposal assessments. MS PEC-funded research has influenced and addressed key policy areas identified through active consultation with stakeholders including UK government departments and devolved administrations. During its first phase, the PEC identified challenges in quickly responding to rapidly emerging policymaker evidence needs. Into its continuation phase, the PEC has sought to address these challenges through evolving its funding models and increasing its in-house research capacity. MS PEC has driven systems change by shaping policy processes, inspiring inclusive research practices, and promoting the use of evidence in decision-making. Looking ahead, its focus is on sustaining impact, increasing global policy engagement alongside more local and regional engagement in the UK, and securing long-term funding.

D.6.2. Introduction

Modern slavery affects an estimated 40 million people globally and imposes a significant financial burden on the UK, with annual costs estimated between £3.3 and £4.3 billion. Former Prime Minister Theresa May described it as "the great human rights issue of our time." Although the UK is often viewed as a global leader due to its robust legal and policy framework—including the landmark 2015 Modern Slavery Act and its supporting strategy—gaps remain. Public understanding is still limited, and existing systems of law, economics, and culture fall short in offering sufficient protection against exploitation.

To tackle these shortcomings, the Modern Slavery and Human Rights Policy and Evidence Centre (MS PEC) was established with funding from Wave 2 of the Strategic Priorities Fund (SPF). Its mission is to enhance understanding of modern slavery and transform the effectiveness of law and policies designed to address it. Since then, it has received further

funding from AHRC for 3 years ending in 2027. This additional funding is aimed at assisting the programme to bring more of its research capacity in-house and focus on future sustainability, including long-term financial security.

MS PEC unites a broad coalition of researchers, policymakers, businesses, civil society actors, people with lived experience and members of the public—bringing them together within the UK—to address this complex global issue. At the heart of the programme is the goal to deepen and reshape the understanding of modern slavery and to foster a coordinated and collaborative response. Central to this effort is the production of policy-relevant research that addresses strategic challenges, enhances knowledge, and drives the development of effective and innovative solutions with policy decision-makers and research communities.

The SPF funded £10million to the programme via the AHRC, with the ESRC as a supporting partner. The Home Office is the key government department involved, as it leads on work to tackle modern slavery. The MS PEC itself was a consortium of six research institutions, led by the Bingham Centre for the Rule of Law (in the initial programme); and in the continuation phase it is a consortium of four research institutions, led by the University of Oxford. Other members of the consortium are:

- The Rights Lab at the University of Nottingham (initial programme only),
- The Wilberforce Institute at the University of Hull,
- The Centre for the Study of International Slavery at the University of Liverpool,
- The Bonavero Institute of Human Rights at the University of Oxford,
- The Alan Turing Institute (initial programme only),
- Bingham Centre for the Rule of Law (British Institute of International and Comparative Law)

The Centre funds research projects through open and responsive calls as well as through work undertaken in the six consortium partner institutions. Since its inception, the Modern Slavery and Human Rights PEC has commissioned and supported over 60 cutting-edge research projects, involving world-class researchers working with a broad and diverse set of partners, focusing on tangible impact on legislation, policy and practice. In September 2024, the Centre launched a new funding call, looking into the effectiveness of interventions to prevent modern slavery, with a focus on prevention before harm occurs and prevention of re-trafficking. The call was able to build upon synthesis pieces that brought together findings from all PEC funded research, as well as input from lived experience participants, policymakers and academic experts.

Two projects have received important funding under this call which will report in 2026:

- Readiness to work as prevention of re-trafficking.55 An evaluation of the Sophie Hayes Foundation employability programme. This research is led by Dr Nicola Wright at the University of Nottingham, in collaboration with the Sophie Hayes Foundation.

55 https://www.modernslaverypec.org/research-projects/readiness-to-work-as-prevention-of-re-trafficking

- Evaluating the effectiveness of the Employer Pays Principle (EPP) in preventing modern slavery in healthcare supply chains.56 This research is led by Dr Mei Trueba at the University of Sussex, in collaboration with the University of Newcastle, Impact Ltd and Unseen UK.

Further information about the Centre and the projects it has funded can be found on their main website.57

D.6.3. Programme design and delivery

A collaborative approach

A key objective of the MS PEC is to strengthen policy impact of funded research projects through a collaborative approach. This has involved regular meetings with partner project teams to discuss and refine policy impact ambitions, facilitate connections with relevant policymakers, and identify specific opportunities for impact. The MS PEC team also work with funded projects to produce a 'research summary' - a concise, accessible report summarising research findings and related recommendations for a non-specialist audience. Key policymaker stakeholders have included (among many others) the Modern Slavery Unit at the Home Office, relevant officials at the Foreign, Commonwealth & Development Office and the Scottish, Welsh and Northern Ireland Governments. Because of the regular dialogue with a range of policy stakeholders, the Centre has been able to develop good understanding of the existing landscape and adjust its research priorities accordingly, leading directly to tangible impact on law and policy.

Recommendations from the Centre's evidence submission to a Home Affairs Committee Inquiry on Human Trafficking in 2023, for example, led to the Home Office starting to publish additional National Referral Mechanism (NRM) data on the reasons why individuals receive negative decisions regarding their status as a victim of modern slavery. The publication of this data helped to clarify the links between modern slavery, irregular forms of migration, and asylum claims. Further, the Centre held over 80-100 meetings each year with key national and international policymakers. The PEC has delivered evidence on many areas of particular interest to policymakers, such as the identification of child criminal exploitation and understanding the risks of modern slavery in the construction sector (amongst many others), informing and furthering these.

The PEC also developed relationships with international institutions and policymaking bodies, such as the International Labour Organisation and the Organisation for Security and Co-operation in Europe. In December 2024, the PEC held a workshop with the Council of Europe's Group of Experts on Action against Trafficking in Human Beings (GRETA) to coincide with their country visit to the UK, to monitor the UK's compliance with the European Convention on Action against Trafficking.

It is noteworthy that efforts were made for the second phase of the programme to shift in response to learnings from the first phase. As discussed above, a key change was to increase

56 https://www.modernslaverypec.org/research-projects/preventing-debt-bondage-in-healthcare-supply-chains

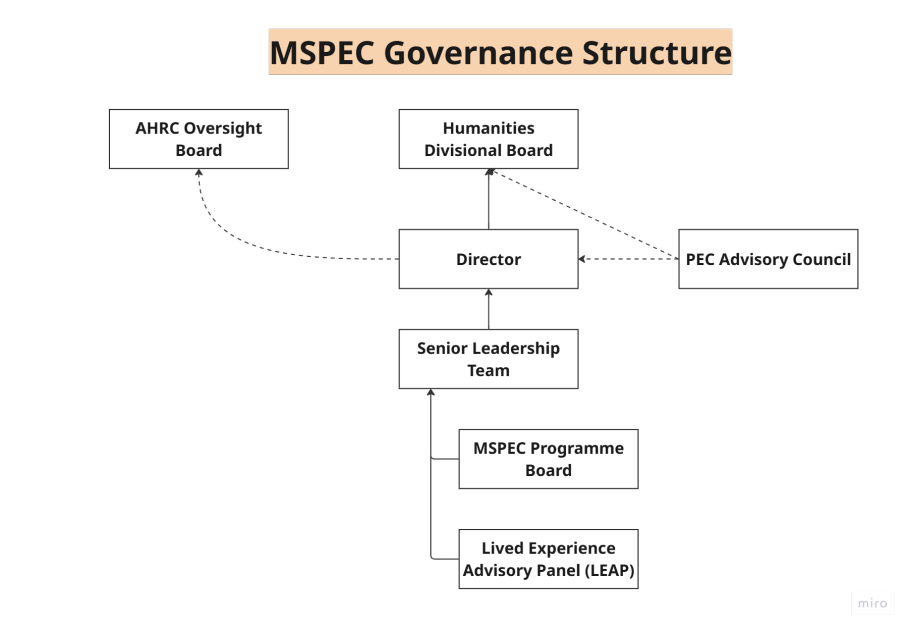
57 Modern Slavery and Human Rights Policy and Evidence Centre: https://www.modernslaverypec.org/all-projects

the PEC's in-house research capacity and strengthen links across its consortium partnership, in recognition of challenges identified during the initial programme phase around producing evidence that can respond in a timely manner to rapidly evolving policymaker needs. Greater in-house research capacity has positioned the PEC to be able to produce research outputs more rapidly and flexibly, ensuring it can speak directly to emerging political priorities.

Another collaborative working practice is the way MS PEC has built and sustained an inclusive 'network of networks' of producers and users of modern slavery research. To achieve this, and through the programme's leadership, there have been a number of working practices used to foster collaboration across different sectors involved. Some of these practices feature in the programme's partnership principles, which specifically mention stakeholder engagement and collaboration.

One example of these principles is embedding key partners in the programme's governance structure. For instance, (in the initial programme) the Senior Management Board (SMB) comprised representatives from the six main partners that constitute the Centre, as well as the Centre's Senior Leadership Team and AHRC's Senior Responsible Officer. The Board met quarterly and was responsible for strategic direction, outputs and impacts of the Centre. It helped to develop call specifications, proposed the future direction of the Centre, identified research gaps and further opportunities, and managed risk. In addition to this, the Centre had a further Advisory Board (in the initial programme), and an Advisory Council (in the continuation phase) that comprises representatives from academia, civil society, NGOs, Home Office, international organisations, and independent members. Its purpose is to offer advice and guidance to the Centre for consideration when developing or delivering its work (the figure below shows the governance structure in the continuation phase).

Figure 5 Modern Slavery PEC governance structure (as of March 2025)



Another example of MS PEC's ability to develop a 'network of networks' has been through its model of co-funding (where both parties contribute financially to a project) and co-commissioning (where both parties jointly develop the scope of a project) with government departments and agencies. This has been a positive mechanism to build in policy relevance

throughout the project's life cycle. For example, the Centre co-funded research with the Northern Ireland Department of Justice that was led by Ulster University and the International Organization for Migration (IOM). The project explored the identification of modern slavery and human trafficking in the context of child criminal exploitation in Northern Ireland and made evidence-informed recommendations to inform the cross-government action plan on child criminal exploitation.

Finally, another collaborative practice cited as having a great impact was strengthening the role and voice of PWLE of modern slavery and those who work closely with them. In addition to encouraging and supporting lived experience engagement by funded partners and others, the PEC recruited a Lived Experience Engagement team in 2022 and established a Lived Experience Advisory Panel (LEAP) in 2023. Since 2024 the LEAP and Lived Experience Engagement Team members have directly supported research and taken active roles in meetings with policymakers. This has included meetings with Kari Johnstone58 (the Organisation for Security and Co-ordination in Europe's Special Representative on Human Trafficking) as well as speaking at conferences such as Tech Against Trafficking59 and the Annual Financial Crime Symposium60 in Jersey.

Overall, MS PEC has diversified the pool of people and organisations working together, created communication channels, and accelerated the processes around collaborative working. The Centre has, for example, organised workshops on building partnerships between researchers and the third sector and chaired roundtable discussions with research teams, policymakers and PWLE.

For instance, a January 2025 parliamentary event was co-convened by the PEC and the All-Party Parliamentary Group on Human Trafficking and Modern Slavery to discuss 'Can the UK Lead the World Again in the Response to Modern Slavery?'. Additionally, several of those either co-leading or partnering with the PEC have a visible presence across government forums, working groups and advisory groups, contributing to PEC's wider impact, including:

- Dr Sofia Gonzalez de Aguinaga (Bingham Centre) is representing the PEC at the Home Office's Forced Labour Forum, which has been set up to inform revisions to statutory guidance on transparency in supply chains and sits on the Expert Advisory Group for the FCDO-funded research on a National Baseline Assessment on the implementation of the UN Guiding Principles on Business and Human Rights in the UK.
- Dr Wendy Asquith is representing the PEC on the Advisory Group to inform the evaluation of the Home Office's Modern Slavery Fund (the £24m Official Development Assistance fund to address modern slavery overseas).
- Dr Alicia Heys is a member of the Crown Prosecution Service's Modern Slavery National Scrutiny Panel, an initiative aimed at increasing transparency around how the Crown Prosecution Service responds to and approaches modern slavery cases.

58 https://www.linkedin.com/posts/modern-slavery-pec_it-was-a-great-pleasure-to-meet-with-the-activity-7263209711565434880-sjWn/?utm_source=share&utm_medium=member_desktop

59 https://x.com/SlaveryPEC/status/1858552263536525314

60 https://x.com/SlaveryPEC/status/1859567056414187705

- Dr Marija Jovanovic has hosted or spoken at several events including the launch of the report by the UN Special Rapporteur on Contemporary Forms of Slavery, Professor Tomoya Obokata, on 'Contemporary Forms of Slavery Affecting Incarcerated People' hosted by the UCL Faculty of Laws on 4 June 2025 and represented the PEC at the conference marking the 10th anniversary of the MSA 2015 organized by Oxford Brookes University on 19 June 2025.

Inter-disciplinary and intersectoral approach

Modern slavery is a complex and multifaceted challenge covering various forms of exploitation embedded across different sectors. By developing a research agenda that brings together different academic disciplines and sectors, the MS PEC has made it possible to tackle this complexity. Examples of programme disciplines include sociology, anthropology, criminology, law, humanities and health sciences. For instance, one of the PEC's funded research projects analyses the key ethical issues involved in conducting high-quality modern slavery research and brings together experts in postcolonial politics, human geography and law. While the PEC is far from the only voice advocating for interdisciplinary research, and other funding schemes can and do support such work, the PEC's unique contribution has been to bring an interdisciplinary approach to its role as a responsive evidence partner to policymakers. This has involved identifying and framing research topics through different disciplinary lenses, drawing on a wide knowledge base.

Besides academic disciplines, the programme approach includes involvement of multiple stakeholders in shaping the research process, which is a key element in the research funded by the Centre.

In addition to research organisations and academics, the funded research project teams consist of NGOs and third sector partners, business associations and PWLE and affected communities (as discussed above). This was partially shaped by existing UKRI/AHRC funding call rules where a maximum of 30% funding (of the total budget) was allocated to a non-academic/third sector organisation. As the PEC's approach to funding developed, it was agreed that this needed to be revised upwards to align with principles of equitable co-production.

The new funding model implemented by the MS PEC allows UK-registered charities as lead organisations in the projects and increases up to 50% the total budget that can go to third sector organisations. This model included a two-stage application process with a shorter expression of interest before submitting a full proposal in the second stage. First, during the grant proposal process for programme research calls, the Centre introduced pre-panel meetings where policymakers and PWLE were invited to review and offer feedback on submitted proposals directly to the panel. This feedback is then discussed further in the main panel meeting. The process is found to be hugely beneficial, especially among the policymakers in increasing the policy relevance of the research.

In 2022 stakeholders highlighted that challenges arose in assessing proposals. This was due to the fact that a relatively small research community is involved in the field and conflicts of interest arise between applying and reviewing roles. To address this, the Centre established a Peer Review College of over 50 experts and continuously refines its assessment process based on stakeholder feedback.

D.6.4. Programme outputs, outcomes and impact – R&I to address priorities

It was largely felt that the programme addressed government's R&I priorities owing to the working practices and collaborative mechanisms put in place by AHRC. For instance, engaging the Home Office in the bid development phase and the PEC Advisory Board during phase 1, resulted in a trusted partnership and long-term engagement with the programme into the continuation phase, and which in turn has increased research uptake. In addition to academic publications, results from the funded projects and from the in-house research conducted by the consortium members are published in research summaries, interim outputs, policy briefs, blog posts and podcasts.61

Stakeholders indicated that research outputs had significant relevance to both UK and international policy end users. It was further felt that outputs are having a short-term impact on raising public awareness of modern slavery in the UK. For instance, a project on 'Framing modern slavery' produced a messaging guide on effective ways to communicate modern slavery to the British public based on research that included extensive engagement with people with lived experience. The project identified limitations to common perceptions of modern slavery and identified more effective narrative framings to increase understanding of modern slavery, enabling a more evidence-based and survivor-informed public debate. The research was disseminated through a report, a messaging guide, a blogpost and an online seminar.

Other examples of R&I outputs being utilised by different end users include:

- The PEC fed into the development of the Home Office Action Plan (2025) on modern slavery and was referenced under Action 1 of the Plan: 'Collaborate with civil society to identify long-term interventions to prevent modern slavery'62
- The Centre contributed extensively to the review of the UK government's Modern Slavery Strategy.63
- In 2021, the Centre was invited by the Home Office Modern Slavery Unit to co-host a roundtable event that brought together academic and third sector researchers, research council representatives and policymakers to inform considerations around how research and evidence could be embedded in the UK's strategic approach to addressing modern slavery.

The requirement to work collaboratively with non-academic partners in the research projects has changed the nature of the outputs and made them more relevant for practitioners and policymakers.

As a result, some of the PEC's outputs have gained substantial policy uptake. For instance, the Centre's submission64 to the Joint Committee on Human Rights (JCHR) call for evidence

61 https://www.modernslaverypec.org/latest

62 https://committees.parliament.uk/publications/47622/documents/248850/default/

63 Modern Slavery Strategy: https://www.gov.uk/government/publications/modern-slavery-strategy

64 Joint Committee on Human Rights (JCHR) evidence submission: https://www.modernslaverypec.org/resources/submission-nationality-borders-bill

on the Nationality and Borders Bill was cited in parliamentary debates and in the JCHR's report on the Bill.

Policy briefings are developed in parallel to ongoing PEC-funded research, synthesising findings and ensuring uptake by different end users. These can be found on the MS PEC's main website:65

- Effectiveness of forced labour import bans
- Effectiveness of mandatory human rights and environmental due diligence
- Effectiveness of public procurement measures in addressing modern slavery
- Survivor support
- Impact of the Covid-19 pandemic on modern slavery
- The Illegal Migration Act modern slavery provisions
- The Rwanda Treaty and Bill and the UK's legal obligations towards victims of modern slavery and human trafficking

To date, PEC have published 111 research reports and summaries, 17 policy briefings, 76 blogs, 42 news stories, 17 podcasts and held 9 online events and 5 in-person events. They have also featured in various high profile media outputs, from the BBC, the Guardian, the Independent, the Times, I News, PA Media, Evening Standard, Huffington Post, Forbes, to local media. Coverage has also been received in more specialised outlets ranging from Children and Young People Now to InfoMigrants, Police Professional, Sourcing Journal, Sustainable Views and Open Democracy. Several articles looked back at ten years of the Modern Slavery Act, drawing on insights from PEC experts:

- **Prof Alex Balch** (PEC Director of Research) analysed the Act's impact for The Conversation, focusing on human rights.
- **Murray Hunt** (PEC Director) provided an expert human rights perspective for the University of Oxford.
- **Dr Sofía González De Aguinaga** (PEC Research Fellow on business in supply chains, The Bingham Centre for the Rule of Law at BIICL) discussed the Act's Transparency in Supply Chains measures for Reuters.

Additionally, several blogs by lived experience experts have been published on the PEC website on issues such as professionalising lived experience, and the potential impact of the Illegal Migration Act or the Rwanda policy.

A one-day conference held in March 2025 drew learnings from PEC work to reach different end users: 'Ten years on from the Modern Slavery Act: Where next for modern slavery law and policy?' The conference marked the 10th anniversary of the Modern Slavery Act and discussed the state of policy and law addressing modern slavery in the UK. This landmark event brought together more than 220 people including policymakers, lawmakers, people with lived experience of modern slavery, researchers, practitioners, businesses and others

65 Policy Impact Reports: https://www.modernslaverypec.org/policy-impact

from across and beyond the modern slavery sector. It was the first time the PEC had organised an event on this scale.

The Centre's profile and expertise has also led to a series of co-commissioned research projects with several important actors who make and influence modern slavery policy. These include the Department of Justice at the Northern Ireland Executive, the Justice Directorate at the Scottish Government, and the Office of the Director of Labour Market Enforcement.

In 2022, stakeholders identified two key challenges in addressing government R&I priorities: mismatched timelines between research and policymaking and shifting political rhetoric around modern slavery. While the Centre introduced agile funding to allow for more responsive research and more targeted impact, short timeframes limited the extent of collaboration possible within projects (e.g. by making it more difficult to implement meaningful lived experience engagement). There were also some limits to the impact that could be achieved within each project's funded period. The PEC's increased in-house research capacity during its continuation phase has aimed to address these challenges, by combining the ability to respond rapidly and flexibly to emerging policy and evidence priorities with capacity to ensure equitable and diverse collaborations, including with people with lived experience. Additionally, changing government priorities made trust-building harder, particularly between government and third-sector partners. As an impartial evidence centre, MS PEC must carefully navigate its role within this evolving policy landscape to maintain credibility and influence.

D.6.5. Programme outcomes and impact – ecosystem change

The ability of the programme to raise awareness of lived experience and incorporate that in wider policy discussions, was noted as evidence of ecosystem change. It is noteworthy that whilst engagement with lived experience experts and active discussions with government occurred during the project, it is anticipated that this work will go on to have longer-term impact on shaping the policy landscape. Involving PWLE in programme design and delivery by embedding lived experience within the PEC's core team, further fostered trust and co-production with lived experience amongst project partners, researchers, and government.

Other interesting examples of practices developed by MS PEC that are early signs of ecosystem change include:

- Policymakers report an improved understanding of evidence in policymaking, which is believed to help create better and more inclusive policies. This is exemplified by
- the Home Office's 2025 Modern Slavery Action plan which identifies the PEC as one of their key partners in delivering action in relation to its first pillar; to develop an approach to prevention, in particularly collaborating with government to better understand 'what works' in terms of prevention and early intervention and to embed the work into broader Government programmes and missions.
- The MS PEC's research commissioning approach, which balances academic independence with government interests, is influencing AHRC's discussions with departments on future investments relating to key areas of interest for government departments, particularly around the government missions.
- Programme structures supporting equitable partnerships and the involvement of people with lived experience, developed by the MS PEC, have influenced recent AHRC

programmes on indigenous research partnerships and disability-inclusive global development, and are under consideration for broader application in programmes such as the new research programme on gambling harms.

- Finally, the MS PEC's investment in dedicated policy impact roles has sparked AHRC's interest in integrating professional knowledge brokers across future projects, with cross-council discussions underway on their training and development.

D.6.6. The Future

One strategic focus of the Centre's work for the remaining period of the funding is to increase its international focus. This remains challenging given the recent cuts to Official Development Assistance in the UK and across Europe, including the loss of the US Agency for International Development. However, the new aid landscape makes it even more important to understand the impact of these changes on vulnerability to and drivers of modern slavery. FCDO, alongside the Home Office, remain important partners in working towards this aim. FCDO, for example, commissioned the MS PEC to assess the nature and effectiveness of survivor engagement in international policy and programming on modern slavery.

The importance of the continuity of MS PEC beyond the SPF funding period was also stressed. For instance, this could include further developing the PEC's ambitions to increase their engagement with local and regional government within the UK, exploring what a place-based approach to research-policy engagement with frontline actors on modern slavery could look like. Future research could also include further business partners, although there is sensitivity from businesses around how they want to be involved and the wider implications of their involvement.

As noted, the Centre has already contributed a great deal to UK government thinking and approaches to modern slavery, including in devolved administrations. It brings convening power across stakeholders and sectors, showing it is possible to conduct high quality policy-relevant research in an extremely sensitive area. It is anticipated that the Centre will create a sustainability plan to ensure future funding for its mission statement.66 The MS PEC team hopes to continue to see involvement and contribution from UKRI in developing a long-term funding strategy.

In May 2025, the MS PEC programme is a year into its continuation phase of funding and will be completed in 2027. AHRC continues to actively support and engage with MS PEC and its funded research through the continuation period. The team will further draft a future mission statement and funding strategy for the period after the current funding comes to an end as issues relating to modern slavery cannot be confined to an 8-year research programme. It is also anticipated that future funding and research will have an increased international focus, as the challenges explored have wider dynamics and cannot be addressed through a UK lens alone.

Multiple programme outputs have already been published on the programme's publication page, including research summaries, policy briefs and research reports. As discussed, there is also evidence of active discussions between government officials and researchers on the

66 Mission statement: https://www.modernslaverypec.org/about-us

programme. For example, one project involves a close collaboration between the PEC, the lead funded researcher and Scottish Government officials, working to embed a prevention approach within the delivery of the Scottish Government's Trafficking and Exploitation Strategy 2025. This builds on the findings of a previous PEC-funded project 'Prevention of adult sexual and labour exploitation in the UK: What does or could work?' PEC is therefore impacting government strategies and approaches.

D.7. National Timing Centre

SPF Wave 2	SPF funding amount: £44m (incl. £14m extension)	Programme Start and end date 17/07/2019 - 29/03/2025
Lead Council / PSRE: NPL	Other Council / PSRE: IUK	Government departments/bodies: MoD, GCHQ and DfT
Other partners • Ofcom • UKSA • BBC • JISC • And others		
Key objectives • Objective 1: Deliver a resilient UK national time infrastructure through the building of new Resilient Enhanced Time Scale Infrastructure (RETSI) facilities, with the potential to network these in the future to provide accurate and resilient time from multiple secure geographic locations. • Objective 2: Provide innovation opportunities for UK companies through funding projects in partnership with Innovate UK based on a successful NPL and Innovate UK partnership model. • ·Objective 3: Respond to the specialist skills shortage in time and synchronisation solutions through specialist, apprentice and post graduate training opportunities.		

D.7.1. Summary

Led by the National Physical Laboratory (NPL), the National Timing Centre (NTC) programme is building the UK's first nationwide network for distributing precise time. This new system will reduce the UK's dependence on global navigation satellite systems (GNSS) by providing a more resilient domestic source of time and frequency, thereby bolstering confidence in the nation's critical national infrastructure. The NTC programme, funded by the Strategic Priorities Fund (SPF), has made significant strides in enhancing the UK's timing infrastructure and resilience. The programme has driven an increase in high-quality multi- and interdisciplinary research (MIDRI) by fostering collaboration between government departments, agencies, academia, and industry. This intersectoral collaboration was structured through a management board, steering committee, innovation competitions, fostering a community of interest, sector expert engagement, secondments, and innovation nodes at universities. The programme's MIDRI approach was crucial in addressing complex challenges related to timing infrastructure, such as developing resilient timing solutions and secure timing infrastructure.

The NTC programme has contributed to addressing government R&I priorities. The programme's focus on backup systems in case of GNSS failure or other disruptions directly addresses government priorities related to national security and resilience. The development of two connected sites establishing a timing signal not reliant on Global Positioning System (GPS) is a concrete example of how the programme is contributing to these priorities. The programme has also supported the implementation of a policy framework related to timing resilience and the creation of the National Positioning, Navigation and Timing (PNT) Office, which works to improve resilience in relation to PNT through policy, coordination, and delivery.

In terms of responding to strategic priorities and opportunities, the NTC programme has demonstrated a capacity to adapt and evolve in response to changing circumstances, technical challenges, and emerging needs. The programme's initial vision included four interconnected atomic clock sites, but challenges related to technical complexities, cybersecurity requirements, and funding constraints led to a revised scope, ultimately delivering two operational sites and a pre-production environment. The programme has also gained increasing relevance as a result of new external events and geopolitical shifts, such as the rise of intentional jamming and spoofing of GPS systems during global conflicts. The programme's success in developing practical solutions and influencing national policy demonstrates the value of a MIDRI approach to research and innovation. The future of the NTC programme appears promising, with a strong emphasis placed on building upon the initial demonstrator and transitioning the NTC from an R&D project to a fully-fledged national asset.

D.7.2. Introduction

The SPF is an £831m investment in MIDRI across 34 themes that align to UK Government areas of research interest. The NTC, which sits within the NPL was funded under the second wave of SPF funding. Its overall budget is £30.3m and the centre commenced operations in July 2019 (a few months later than the target of April).[67] NPC was a five-year programme and was completed in March 2025 after a change request was successfully submitted to extend the deadline by one year. This extension was requested due to the increasing complexity of the project which was previously underestimated and realisation that further cybersecurity development would be needed. The programme scope was revised to reduce the number of sites from four to two and greater resource was allocated to cybersecurity. A further £7.1 million in funding was awarded to support this.

The strategic reasons for the NTC run across the entire UK economy. Modern industrial economies rely on very precise PNT technologies. Aircraft, ships and (increasingly) road vehicles require very accurate position and navigation data access. Financial transactions require extremely accurate 'date stamps' for validation and fraud monitoring and auditing – not least because automated flash trading (in particular) relies on exploiting extremely fast buy or sell opportunities. Similarly, the national grid and electricity markets now rely on *phasor*

[67] Work began in April 2019, although the contact for the programme was not signed until late (December) 2019. Therefore up until December 2019 NPL were working at risk, which presented a barrier to working to the intended timeline.

measurement units, electronic devices that measure voltage and current thousands of times per second in order to optimise generation and transmission systems. Any degradation in the accuracy of phasor measurement due to a breakdown in timing synchronisation can lead to cascading problems that, if left unstopped, can create electricity blackouts as the system of closely coupled electricity supply and demand flux management breaks down. Similar issues exist in telecommunications systems. In short, a large part of a modern industrial economy (and national security) relies on PNT capability. This creates 'upside' opportunities for developing new markets, technologies and supply chains, but also 'downside' risks if PNT systems fail – or are attacked by adversaries. One estimate puts the reliance on PNT at around 11 per cent of GDP[68], a reliance likely to increase in the future.

The NTC programme is a collaborative effort spearheaded by the NPL which aims to bolster the UK's timing infrastructure and resilience against potential disruptions to GPS. Interview feedback revealed the NPL's multifaceted approach to the programme, encompassing the development of a distributed timing network, exploration of innovative applications for resilient time signals, a market study to identify key use cases and target markets, and a parallel education and communication programme. Innovate UK's role involved funding R&D projects to explore applications of the new timing signal, alongside a market study to understand the potential impacts of resilient timing.

While the initial vision included four interconnected atomic clock sites, challenges related to technical complexities, cybersecurity requirements, and funding constraints led to a revised scope, ultimately delivering two operational sites and a pre-production environment. Despite these adjustments, the programme has made significant strides in enhancing the UK's timing capabilities, fostering innovation, and addressing skills gaps in the time, frequency, and synchronisation domain.

D.7.3. Programme design and delivery

Intersectoral working and collaboration in implementation

Feedback from those involved in the delivery of the NTC programme suggests it has involved intersectoral collaboration across government departments, agencies, and with academia and industry. The Ministry of Defence (MoD) and Government Communications Headquarters (GCHQ) were identified as key stakeholders and delivery partners early on as part of the business case. The Department for Transport (DfT), Department for Science, Innovation and Technology (DSIT) and the Department for Business and Trade (DBT) were also engaged with the programme. The NTC programme has been in contact with regulators such as the Financial Conduct Authority (FCA) and Ofcom on a regular basis in order to disseminate the importance of resilient timing and support their preparedness for change in the future. Furthermore, the establishment of timing innovation nodes at universities including Surrey, Strathclyde, and Cranfield, alongside two business innovation competitions run by Innovate UK, indicates collaboration with the higher education sector and industry.

[68] Winning Moves (2017) The National Measurement System: Customer Needs and Impact Survey. Cited in NPL (2020) The Economic Impact of the National Timing Centre on Collaborating Companies. NPL Report IEA 2, Feb.

Structure and mechanisms of intersectoral collaboration

Intersectoral collaboration as part of the NTC programme is structured through several mechanisms:

- Management board: This is the core decision-making body, comprising partners directly involved in programme delivery (NPL, GCHQ, MOD, Innovate UK, and DSIT).
- Steering committee: This is a broader body that provides strategic direction and ensures alignment with government priorities. It is also used to disseminate knowledge and progress updates across partners. It includes representation from various government departments (including NPL, DSIT, DfT, MoD, GCHQ) and, at a high-level, was set up to provide guidance and oversight.
- Innovation competitions: Innovate UK ran competition calls for feasibility and demonstration studies, co-funded with private sector investment. These competitions provided funding and expertise to private companies.
- Community of interest: The programme aimed to bring together the 'timing community', including industry, academia, and government departments/bodies. This was facilitated through the dissemination of tailored e-learning, meetings and outreach activities with government groups such as the National Resilience Committee and National Preparedness Commission. Industry bodies such as the Royal Institute of Navigation were also engaged which has continued to establish a 'sector to sector' partnership.
- Sector expert engagement: The programme actively sought input from sector experts to ensure the relevance and future proofing of developed solutions.
- Secondments: Personnel from organisations such as the Atomic Weapons Establishment (AWE) and Ofcom were seconded into the programme to provide specific expertise and gain an understanding on how their sector could be impacted.
- Innovation Nodes: The creation of innovation nodes by NPL at universities have fostered collaboration between academia, industry, and government, providing access to expertise and resources.

A total of seventeen projects were successful in the first Innovate UK competition launched in 2021, titled 'Innovation in Time Dissemination and Application'[69], and received £2 million in grant funding overall. The competition supported the work of the NTC programme and aimed to:

- Support and enable business-led innovation across the UK supply chain in resilient time, frequency and synchronisation (TFS) for the development of products, services and end user applications;
- Develop a TFS ecosystem and capability for relevant industries and critical national infrastructure, and;
- Disrupt and create new markets to improve the provision of TFS.

[69] Competition overview - Innovation in time dissemination and application - Innovation Funding Service

The majority of funded projects were feasibility studies that explored a range of dissemination modes (terrestrial, broadcast and satellite) to utilising existing infrastructure, the majority of which involved developments that are complementary to GNSS and are intended to contribute to TFS system resilience. Other projects focused on hardware and time transfer protocols over fibre.[70]

An additional £4.7 million was provided through a second competition titled 'Innovation in Time Resilience, Dissemination & Application'. This competition sought to fund innovators able to contribute to resilient TFS, and its dissemination and application. The first competition focused on feasibility studies, whereas the second focused on funding demonstrator projects.

An example of the work being done through an innovation node includes Chronos Technology and Strathclyde's Physics Department accessing 1PPS (pulse-per-second[71]) signals for their NTOL (NPL Time Over eLoran[72]) project which aims to demonstrate the broadcast of the national time-base across the UK using the eLoran transmitter based in Cumbria. Another example based at the University of Cranfield between Iquila Ltd and the School of Aerospace Transport and Manufacturing (SATM) involves accessing NTC for their Disseminated Secure QuanTime Autonomy (DSQTA). DSQTA aims to establish the evidence base for redistributing PNT data to air and ground autonomous systems and demonstrate the technologies and software required for safe, reliable, and secure autonomous transport in the future. Furthermore, to enhance the resilience of electricity grid performance measurement, Sygensys Ltd. is collaborating with the University of Surrey's 5G/6G Innovation Centre on the EGridSync project. By utilizing 1PPS timing signals, EGridSync will provide Sygensys with the resilient timing reference needed to develop innovative products and services for electricity grid management.[73]

Extent of previous collaboration

Stakeholder knowledge of the extent of prior collaboration between the stakeholders/organisations involved in the NTC programme is limited. However, the programme aimed to formalise and enhance relationships across partners. It was noted that the programme acted as a "forcing function", bringing together organisations that "should speak more often" but may not have done so without the programme.

New ways of working and collaborating between partners in governance, management and delivery

The programme has explored new and enhanced ways of working and collaborating across organisations/sectors. The creation of the management board and steering committee formalised governance structures that did not exist previously. The NPL also actively sought to expand its network by engaging with a wider range of government departments, bodies and sector experts. The use of secondments and the establishment of innovation hubs further

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[70] National Timing Centre competition - NPL

[71] Part of a class of electrical signals

[72] eLoran: Enhanced Long Range Navigation- is a terrestrial-based Positioning, Navigation and Timing (PNT) system that uses transmitters operating within the 90-110 kHz low frequency band.

[73] NPL National Timing Centre innovation nodes webpage

facilitated knowledge sharing and collaboration in ways which were not previously in use. The programme also aimed to foster a "community of interest" around timing, bringing together diverse stakeholders to share information and coordinate efforts. It was suggested that significant progress has been made in raising awareness about the potential threat to timing resilience and navigation as a result of the NTC programme, evidenced by the establishment of the PNT office and interest from other states such as the US and Japan and the Royal Institute of Navigation. However, it was suggested more needs to be done to stress the importance of resilient time across departments.

One significant aspect of intersectoral collaboration and a tool used to disseminate knowledge, while stressing the importance of resilient time, was the parallel education and communication programme. This initiative aimed to ensure that individuals across different sectors and organisations understood the challenges and threats the programme was addressing and its relevance.

A free, self-led learning package was developed, allowing individuals to acquire the necessary knowledge to engage with the NTC effectively. This e-learning course was completed by around 1,500 policymakers and other users globally. Stakeholders reported that innovation leads from Net Zero and digital technologies found the training beneficial, indicating a positive change in their understanding. Furthermore, companies working on power grid systems used the training to educate their partners, highlighting its broader impact. This suggests that the programme has successfully contributed to an enhanced understanding and knowledge base of timing across different sectors.

The NTC programme also facilitated knowledge sharing and collaboration with the MoD and GCHQ. Regular updates were shared through the steering committee, and the programme benefited from their expertise in security. A mutually developed security aspects letter enabled the secure flow of information between organisations, facilitating better collaboration on aspects involving classified information.

However, stakeholders reported a source of tension within NPL created by its structure, which requires the organisation to support the UK's prosperity while generating income. This has made it difficult to collaborate using commercially sensitive information (which could then be used to generate income for the NPL).

Feedback suggests the NPL often has differing priorities to government bodies focused on national security as it is tied to monetising NTC technology and generating income, whereas defence departments are tasked with prioritising national security. This difference in priorities could potentially influence decision-making, with NPL prioritising income generation over what might be considered best for the nation.

The steering committee's effectiveness in providing guidance was also questioned. While the committee served as a useful function in disseminating information on progress to relevant bodies within government and its departments, some stakeholders reported that it lacked the authority to truly steer the programme. The technical complexity of the subject matter and the non-technical backgrounds of some committee members were identified as potential challenges. The feedback suggests that a smaller, more focused steering board with technical experts could have been more effective in guiding the programme.

Multi- and inter- disciplinary (MIDRI) approach

Stakeholders reported that the NTC programme involves multiple disciplines that do not traditionally collaborate. The primary example is the integration of advanced scientific research (atomic clocks, timing) with complex engineering, software development, and security considerations. The importance of resilient timing on navigation and potential impacts on the shipping and transport industries also highlights a new area of interest for these sectors which has been encouraged by the NTC programme. One interviewee stated that whilst the NTC was framed as an R&D programme, in practice it was closer to a large engineering project. Since the NPL did not have experience in this type of engineering delivery, it required for the programme to be outsourced to industry which was not the original expectation.

The interviewees also mentioned the importance of understanding market needs and logistics (e.g., maritime logistics) when developing timing solutions. This suggests a need for collaboration between technical experts and those with expertise in specific application domains.

Mechanisms to encourage MIDRI proposals

NTC encouraged MIDRI proposals by promoting programme competitions under Innovate UK's 'complex systems community', encouraging applications from any sector in order to attract diverse perspectives. Innovate UK also worked closely with the Royal Institute of Navigation to access its expertise in the area. However, one interviewee stated they were unaware of any additional requirements embedded in proposals or any enhanced communications specifically designed to encourage MIDRI proposals.

New or enhanced mechanisms to assess MIDRI proposals

Feedback suggests a deliberate approach to assessor allocation was taken at Innovate UK for the assessment of competition bids to ensure a mix of expertise from different disciplines. Some assessors with technological knowledge and others with a greater understanding of the market were selected, and AI was sometimes used to match assessors with proposals. This diversity was intended to ensure that proposals were evaluated not only for their technical merit but also for their practical applicability and market potential. An example of providing a timing signal to the maritime industry was given, and the need to have someone who understands maritime logistics as part of the assessment process.

Shifting of priorities/approach over time

The NTC programme appears to have shifted its approach over time but not its priorities. The main shift in approach was a reduction in infrastructure from four sites to two. This shift was driven by a combination of factors, including:

- Evolving understanding of project complexity: Initially framed as an R&D programme, it became clear that the project would involve complex engineering. This realisation led to adjustments in governance, methodology, and resource allocation. The initial underestimation of the project's complexity, particularly regarding the engineering expertise required, security aspects, and resulting staffing needs prompted a re-evaluation and a need for external expertise. The initial costing model was also insufficient for a project of this complexity. The programme was initially overambitious in its scope, leading to a need for a more developed costing model and a recognition that the initial goals were not feasible within the given timeframe and budget.

- External events and geopolitical shifts: The original justification for the NTC programme was based on the need for an alternative to GPS in the event of failure caused by natural phenomena. However, the rise of intentional jamming and spoofing of GPS systems during global conflicts, particularly the invasion of Ukraine, and the Israel-Gaza crisis, significantly heightened the urgency and relevance of the programme. The COVID-19 pandemic and the increasing reliance on digital infrastructure further emphasised the need for secure and resilient timing.
- Technical challenges: The NTC programme encountered technical challenges related to the range needed to be covered and cost of connecting clocks via secure locations, particularly using dark fibre. While a solution was found, the practicalities of implementing the technology posed significant hurdles.

In summary, the programme demonstrated a capacity to adapt and evolve in response to changing circumstances, technical challenges, and emerging needs. This adaptability helped ensure the programme's continued relevance and impact.

D.7.4. Programme outputs

Responsiveness of the innovation community

The innovation community's responsiveness to the desire for MIDRI proposals was reported to have evolved over time. Initially, there was a reliance on existing systems and a reluctance to take risks with new technologies amongst businesses. However, as the programme progressed and demonstrated the value of improved timing signals, the innovation community became more receptive to the competition calls. The development of a common language and understanding of the programme's goals was a journey, particularly given the diverse backgrounds and delivery styles of participants from the private, academic, and public sectors.

The programme's success in attracting individuals from various sectors and disciplines suggests a positive response from the innovation community. The development of a training course further contributed to skills development and knowledge dissemination, with significant uptake both in the UK and internationally (around 1,500 completes). This indicates a growing awareness and interest in the field, driven by the programme's efforts to highlight the criticality of timing signals.

Comparison with expectations

Feedback suggests that the two Innovate UK competition calls did not maximise the opportunity available. While £7.6 million in grant funding was awarded through the competitions, this was lower than the budget available. The reasons for this discrepancy remain unclear, and the remaining funds were reportedly absorbed elsewhere within Innovate UK. This raises questions about the programme's overall effectiveness and whether it could have achieved even greater impact with full utilisation of its allocated budget.

Using MIDRI to overcome complex challenges

The MIDRI nature of the programme was crucial in addressing complex and multi-faceted challenges related to timing infrastructure. The programme's interdisciplinary approach enabled it to tackle issues ranging from security and infrastructure to research and quantum technology. This required a diverse range of disciplines, including quantum science, engineering, systems engineering, cyber security, and timing distribution.

Examples of complex challenges addressed by the NTC programme include:

- Resilient timing solutions: Developing timing sources that do not rely on GPS or national timing signals, providing alternative solutions for critical infrastructure.
- Secure timing infrastructure: Finding a solution (via dark fibre and the internet) to connect a low security location with a high security location via a single network by addressing cyber security challenges, enabling the secure distribution of timing signals.
- Establishing two connected locations: Infrastructure has been put in place at two sites to connect and establish a resilient timing network, demonstrating the feasibility of the technology.

By fostering collaboration across disciplines and sectors, the programme was able to address these complex challenges in a holistic and innovative manner. The programme's success in developing practical solutions and influencing national policy demonstrates the value of a MIDRI approach to research and innovation.

R&I outcomes

The R&I has resulted in several key outcomes, demonstrating the value of the MIDRI approach. Firstly, the NTC programme has led to the development of a more accurate and resilient timing signal, independent of satellite access (GPS). This has significant implications for various sectors. Demonstrations of this capability have been conducted, showcasing its potential for timing resilience. The programme has facilitated the connection of two secure sites via fibre, satellite, and the internet, overcoming technical and security challenges. This is a unique achievement, with international interest and potential for future export opportunities.

The project has also contributed to skills development in the timing domain, a niche but critical area. Two e-learning courses were developed and have been utilised by people in a range of sectors, with around 1,500 learners using it both in the UK and internationally. These courses are being used by organisations to onboard new staff and upskill their existing workforce. Another important achievement stemming from the programme is the creation of the PNT Office, which works to improve resilience in relation to PNT through policy, coordination and delivery.[74] Finally, the project has supported the implementation of a policy framework related to timing resilience.

Data collected on outcomes

Interview feedback indicates that project completion forms (PCFs) are used by Innovate UK to collect data on the outcomes of funded projects, including Technological Readiness Levels (TRL) and commercialisation efforts. However, a comprehensive analysis of these PCFs across all projects has not yet been undertaken. An end-of-programme evaluation is planned, which will involve an external consultancy reviewing the data provided by Innovate UK to identify key themes and impacts.

[74] National Positioning, Navigation and Timing Office webpage

The programme has leveraged private sector R&D investment, with one competition leveraging a ratio of approximately 0.48 pounds of private spending for every one pound of public funding.

Dissemination has occurred through various channels, including engagement with the National Preparedness Commission to raise awareness of timing vulnerabilities and provide training materials. The Royal Institute of Navigation has also played a role in fostering sector-to-sector relationships. While a full programme report is being compiled, it's likely that only elements of it will be publicly available.

End-user engagement

End-users have been identified and engaged through a combination of proactive outreach and responding to requests. The market study conducted early in the programme aimed to identify potential opportunities in adjacent markets and technologies. Engagement with sectors such as energy, financial services, and telecommunications has been crucial in demonstrating the value of improved timing signals. The programme has also engaged with policy and decision-makers through the National Preparedness Commission and the PNT Office, raising awareness of the importance of timing resilience and influencing policy frameworks.

The training courses developed as part of the programme have targeted decision-makers, policymakers, and budget holders to educate them on the criticality of timing. However, the interviewees acknowledge that not all potential end-users have been reached, and there is a need for continued engagement as the dependency on timing signals becomes more apparent.

Adoption of outputs

The adoption of the R&I outputs appears to be in the early stages. Access to the outputs has primarily been through university nodes for experimental work, indicating a focus on research and development rather than immediate practical application and widespread implementation is not yet fully realised.

One concrete example of potential uptake is a telecommunications company's serious consideration of replacing GPS on their backbone network with the technologies developed through the National Timing Centre. This would be a significant shift, demonstrating a real-world application of the research outputs. However, it's important to note that this is still in the consideration phase.

The interviewees express confidence in future adoption, particularly once the services are commercially available. However, the extent of market adoption remains uncertain and dependent on factors including regulation and perceived benefits beyond basic preparedness.

Relevance to end users

The clocks are perceived to be of higher quality, particularly in terms of accuracy. One interviewee highlights the potential impact of having access to timing accurate to a millionth of a second, compared to the current standard of a hundredth of a second. This level of precision could revolutionise operations in industries such as telecommunications, although wider applications are still being explored.

The relevance to end-users is tied to the ability of the outputs to improve efficiency and resilience. The NTC programme aims to move the nation beyond the perception of time as a readily available and cheap utility (via GPS) and demonstrate the value of a sovereign, robust timescale that is not dependent on GPS. This is particularly relevant for critical national infrastructure and organisations concerned about vulnerabilities associated with GPS.

Addressing the originally identified priority/challenge

The NTC programme has contributed to addressing the original priority of ensuring resilience to threats to critical national infrastructure related to GPS timing and the concerns raised in the Blackett report on GNSS.[75] By developing alternative timing technologies, the programme aims to mitigate the risks associated with reliance on GPS, such as jamming and spoofing.

The scale of the contribution is potentially significant. The development of a sovereign timescale could have far-reaching implications for national security, critical infrastructure, and various industries. The creation of the National PNT office, which the programme is said to have accelerated, is a positive step towards addressing the challenges related to PNT in a coordinated and strategic manner.

The implications of the programme's contribution are wide ranging. The outputs will enhance timing resilience and enable new opportunities related to national security and defence. Stakeholders reported that the success of this implementation will be measured by its invisibility – if the transition to a new timing source is seamless and unnoticed, it will demonstrate the effectiveness of the mitigation strategy.

More broadly, the programme has the potential to raise awareness of the importance of resilient PNT and drive policy changes that prioritise the adoption of alternative timing technologies. Follow-up market research being conducted will support industry in identifying opportunities related to PNT, further accelerating the development and deployment of innovative solutions.

It is important to acknowledge that some outputs developed by NPL may not be widely disseminated due to commercial sensitivities. While this limits immediate impact, the knowledge gained in their development could still contribute to future advancements in the field.

D.7.5. Programme outcomes and impact – ecosystem change

Intersectoral working between partners

The NTC programme involved intersectoral collaboration, primarily between NPL, GCHQ, MoD, and Innovate UK, with some engagement from commercial entities. Regular communication and meetings took place between the NPL and other government teams, including weekly calls and site visits, fostering a close working relationship. However, a formal, overarching governance structure with a clear schedule seemed to be lacking at first, leading to challenges in coordinating activities and understanding timelines, but this improved over time. Prior to the programme, the extent of collaboration between these partners varied; the MoD and NPL had some existing relationships, but the programme aimed

[75] Satellite-derived time and position: Blackett review - GOV.UK

to enhance these and establish new ways of working, particularly in knowledge sharing and secure knowledge transfer.

The programme explored new ways of working by building a secure site on MoD premises, necessitating the development of bespoke solutions for sharing sensitive information. However, challenges arose from differing organisational priorities, commercial sensitivities (though not directly experienced by all), and a lack of experience in the delivery of similar programmes at NPL.

Supporting and encouraging MIDRI

The programme experienced mixed success in supporting multi-disciplinary and inter-disciplinary research and innovation (MIDRI). A key challenge was the timing of market development work, which was perceived as premature and hindered adoption of NTC services. While there was value in learning how to interface with external companies within a wider ecosystem, shifting the R&D work forward by 12 months to take place prior to market engagement could have yielded more measurable impacts by demonstrating feasibility and potential application.

Knowledge sharing faced hurdles in some areas due to security classifications and difficulties in transferring commercially sensitive information across organisations. However, a close working relationship fostered excellent cross-organisational collaboration, particularly between two sites, with regular engagement and open communication.

The programme also highlighted the need for improved governance and scheduling, as the lack of a clear schedule made it difficult to plan and initiate tasks effectively at the outset. A significant barrier was the challenge of articulating needs and describing organisational requirements, especially when related to vulnerabilities.

Helping to Address Government R&I Priorities

Interview feedback indicates that the NTC programme is strongly connected to government R&I priorities, particularly in the areas of security and resilience and seeks to address the threat highlighted by the Blackett Review (Satellite-derived time and position: a study of critical dependencies) around the UK's over-reliance on GNSS for precise timing.[76] One interviewee emphasised the programme's alignment with the National Risk Register and the ambitions of the PNT office.

The programme's focus on backup systems in case of GNSS failure or other disruptions directly addresses government priorities related to national security and resilience. The development of a new UK Sovereign two-way satellite time and frequency transfer modem (twist foot) is cited as a concrete example of how the programme is contributing to these priorities. However, stakeholders also reported challenges in raising awareness of the dependency on GNSS and the associated vulnerabilities. One interviewee noted that the lack of awareness among some stakeholders made it difficult to communicate the importance of the NTC and its role in addressing these vulnerabilities. This suggests that while the programme is aligned

[76] GOV.UK, Satellite-derived time and position: Blackett review, 2018

with government R&I priorities, there is a need for greater awareness and understanding of these priorities among stakeholders.

The programme's ability to adapt to unforeseen circumstances, such as the COVID-19 pandemic and the supply chain difficulties triggered by the invasion of Ukraine, is also highlighted as a strength. The decision to front-load procurement and focus on the design phase during the pandemic allowed the programme to continue making progress despite the disruptions. This demonstrates the importance of flexibility and adaptability in addressing government R&I priorities in a rapidly changing environment.

Based on the interview feedback, the programme appears to have fostered positive changes in relationships, communication, and ways of working between programme partners, extending beyond the immediate scope of the project. One interviewee stated that ways of working between programme partners have definitely changed beyond the programme. This strengthening of engagement is noted specifically between DSIT and NPL, with the perceived benefit extending to the government in general. The most prominent joint initiative mentioned was the construction of NTC infrastructure at a secure location in partnership with the MoD. This collaboration was described as a 'learning curve', but directly resulted in a new, valuable capability. This also equipped the programme team to be able to handle future projects with similar strict security requirements.

Even the MoD's role as an interested observer is seen as a positive step, increasing awareness among key players concerning critical national infrastructure. While it was acknowledged that widespread ecosystem change and increased confidence in research and innovation is happening, interviewees emphasise that it may take some time due to the risk-averse nature of stakeholders who want to see proven results before fully adopting new systems. However, other programmes intending to use technology developed within the programme were mentioned, suggesting a potential for sustained effects and broader adoption in the future.

Understanding of research efforts and state-of-the-art evidence has improved amongst government department partners, particularly within the PNT Office, DSIT, and the Cabinet Office. There is a greater awareness that cutting-edge technologies require time and are subject to the uncertainties inherent in research, moving from low TRLs to commercialisation. While this can cause frustration when outputs are delayed, there is also recognition of the effort required. The direct understanding of government R&I priorities amongst research communities and councils has most likely not improved according to one interviewee. However, the programme's high profile has raised awareness of the problem being addressed across different government departments and given the project credibility.

The training component has been valuable regarding chronometry, but could be improved by focusing on the policy and engineering aspects of mitigating vulnerabilities related to time delivery mechanisms and its real-world implications across different sectors.

The programme appears to have had a positive impact on the implementation of MIDRI, confidence in investing in MIDRI, and confidence in applying for MIDRI funding. Interviewees indicated that the programme highlights the necessity of a multidisciplinary approach for complex challenges, fostering collaboration between people from different fields who might not otherwise have worked together.

While the availability of funding was a key enabler, the programme also facilitated a multidisciplinary approach across different sectors such as technology, defence and security

communities. This exposure increased awareness and kick-started interest and work in areas that were previously neglected. Furthermore, the programme seems to have accelerated a general trend towards broadening skill sets and encouraging collaboration within different areas of NPL, moving away from siloed approaches.

The follow-on funding received by NPL suggests improved confidence and belief in their work, and the programme has also built greater capability for the organisation to manage large engineering projects. Finally, the programme has strengthened relationships and communication mechanisms between programme partners, leading to a clearer understanding of common purposes and long-term partnerships centred around new national assets. For instance, the successes achieved through the construction of new NTC infrastructure was built on a foundation of regular communication, including in-person meeting and trips between GCHQ and NPL.

What would have happened in the absence of funding

Without the SPF government funding, the field of resilient timing and the National Timing Centre (NTC) programme would have likely faced significant delays with technological advancement, been addressed in a piecemeal and inconsistent manner, or potentially not materialised at all in its current form.

Interviewees emphasised that the SPF funding was "absolutely critical" and a "springboard" for achieving advancements in this area. Prior to the NTC, the UK did not have a coordinated national timing strategy, and SPF funding was instrumental in pulling the community together to mitigate vulnerabilities, and establish the UK as a world leader in national timing systems, potentially five years ahead of other nations.

While there might have been alternative funding routes through mechanisms like the national measurement system, these would have likely been incremental and insufficient to drive the comprehensive and strategic approach facilitated by the SPF, which elevated the issue to a national strategic priority with endorsement from the Cabinet Office and the National Risk Register. The NTC programme also fostered a greater understanding of the technological need and threat across UK government, leading to the creation of a dedicated office within DSIT to focus on PNT.

D.7.6. The future

The future of the NTC programme appears promising, with a strong emphasis placed on building upon the initial demonstrator. A substantial follow-on programme, potentially spanning ten years, is under serious consideration by the government, aiming to transition the NTC from an R&D project to a fully-fledged national asset. This next phase focuses on completing a core four-site network and establishing distribution architecture to deliver timing signals to critical national infrastructure sectors. This includes extending to broadcast services and expanding training programmes, potentially through doctoral training centres. The programme aims to provide a trusted source of time, giving sectors a competitive and technological edge, while also enhancing resilience against threats to GPS. Furthermore, the UK is positioned to become a global leader in this field, potentially exporting its capabilities, supply chain components, and skills internationally, while also working on the redefinition of the second as a unit of time measurement.

D.7.7. Summary and reflections

The SPF was critical in supporting the NTC's multi- and interdisciplinary research (MIDRI) approach, which proved essential for addressing the complex challenge of creating secure timing infrastructure, and was encouraged through open competition calls with diverse assessor panels.

The programme established new collaborative ways of working by creating formal governance structures such as a management board, facilitating secondments, and establishing university innovation nodes that acted as a 'forcing function' to bring different government, academic, and industry sectors together.

This SPF-funded collaboration successfully addressed government priorities for national security and resilience by developing a domestic alternative to GNSS, a key concern from the Blackett Review, and its work helped accelerate the creation of the National PNT Office.

However, the adoption of the programme's outputs by end-users is still in its early stages, with access primarily limited to university nodes for research and development rather than widespread practical application. While full implementation is not yet realised, there is significant potential for future uptake.

D.7.8. Stakeholders interviewed

Interviews for the final SPF evaluation were conducted 2025 with:

- Jona Ramadani, NPL
- Mike King, NPL
- Srajal Nayak, NPL
- Tim Just, IUK
- Bryan James, MoD
- Dave S, GCHQ
- Leon Lobo, NPL
- Emma Haynes, NPL

The case study also builds on desk research and 7 interviews with programme leads and wider stakeholders conducted for the Interim evaluation report produced in 2022.

D.8. Productivity Institute Programme

SPF Wave 2	SPF funding amount: £42.4 m	Programme Start and end date 01/08/2019 - 31/03/2027
Lead Council / PSRE: ESRC	Other Council / PSRE: IUK	Government departments: DWP, HMT, BEIS.
Other partners: University of Manchester, with the University of Cambridge, the University of Glasgow, King's College London, the National Institute of Economic and Social Research, Queen's University Belfast, University of Sheffield, the University of Warwick, Cardiff University and Oxford Brookes University. Plus the London School of Economics, University College London, Aston University, and the Institute for Fiscal Studies.		
Key objectives • Understanding and Measuring Productivity: The Productivity Institute Programme (PIP) conducts research to identify the causes of productivity stagnation and to develop better methods for measuring productivity, including via The Productivity Institute (TPI) - a £32 million investment bringing together experts, policymakers and businesses. • Enabling Productivity Improvements: TPI works with businesses and policymakers to translate research insights into practical interventions that can improve productivity. • Promoting Interdisciplinary Research: TPI brings together experts from various disciplines to address the complex issues surrounding productivity. • Regional Focus: PIP aims to understand and address productivity issues in different regions of the UK, contributing to a more balanced approach to economic growth. • Impact on Policy and Practice: PIP's research is intended to inform government policies and business strategies, leading to concrete changes that improve productivity.		
Main phases • The Productivity Institute (TPI): a £32 million investment headquartered at the Alliance Manchester Business School at the University of Manchester that brings together world-leading experts from a range of disciplines and works with policymakers and businesses to better understand, measure, and enable improvements in productivity across the UK. • The Programme on Innovation and Diffusion: a £5 million programme that is based at the London School of Economics (LSE) carrying out research on how to boost productivity through nurturing innovation and how to diffuse these ideas across the economy. • Seven thematic investments: £1.5-2 million programmes funded through a call 'Research to improve UK economic productivity' to add to the portfolio of ongoing productivity research.		

D.8.1. Summary

The Economic and Social Research Council (ESRC) secured £42.4m in funding from the Strategic Priorities Fund (SPF) to establish The Productivity Institute in 2019. The Productivity

Institute fostered strong intersectoral and interdisciplinary collaboration, initially supported by ESRC-led dialogues and sustained through regular research events and board meetings.

The primary objective of the programme was to drive sustained and inclusive productivity growth in the UK by understanding, measuring, and enabling improvements. It aimed to achieve this through interdisciplinary research, collaboration with businesses and policymakers, and the implementation of research findings in practical policy and business interventions. It consists of nine separate investments that seek to tackle the productivity puzzle, which is one of the most important issues for the UK economy.

The thematic structure of The Productivity Institute (TPI) encouraged partnerships across economics, engineering, and mathematics. The programme adapted effectively to COVID-19 disruptions, leveraging digital platforms and maintaining alignment with net-zero goals.

TPI delivered substantial outputs in 2023/24, including the completion of research across eight themes, the launch of fellowships, and the release of The Productivity Agenda[77] for the UK government. Regional engagement was a key strength, with research shaped by local needs and uptake by policymakers and businesses. However, national-level influence was limited, with calls for stronger links to high-level decision-makers. Pilot projects demonstrated potential for light-touch interventions in SMEs. Stakeholders noted early signs of ecosystem change, driven by SPF funding and collaborative structures, with notable achievements such as advisory roles in government and leadership in the OECD Global Forum on Productivity. There are ongoing research, policy engagement, and upcoming events until 31st March 2027, including the September 2025 International Productivity Conference, which are expected to extend its impact. The work laid a foundation for integrated, place-based productivity policy, emphasising the need for coordinated, long-term approaches across sectors and regions.

D.8.2. Introduction

The UK's productivity challenge has and continues to be an issue of pressing public policy concern.[78] Since 2008, the UK has sustained a systematic flatlining of its productivity growth across all measures, as defined by the Office for National Statistics (ONS).[79] This gap between the UK's expected pre-crisis trend and its actual productivity growth constitutes the UK's 'productivity puzzle'.

The ESRC secured £42.4m in funding from the SPF (financed by the government's National Productivity Investment Fund (NPIF)) to establish the Productivity Institute Programme (PIP) in response to the UK's productivity challenges. The PIP is an organisation that works across academia, business and policy to better understand, measure and enable productivity across the UK. The PIP, which spanned five years, was the single largest ever investment made

[77] https://www.productivity.ac.uk/research/the-productivity-agenda-report/

[78] The UK's Productivity Challenge: https://www.rand.org/randeurope/research/projects/2023/evaluating-productivity-institute-programme.html#:~:text=The%20UK's%20productivity%20challenge%20is,more%20so%20than%20similar%20countries.

[79] ONS definition of productivity: https://www.ons.gov.uk/economy/economicoutputandproductivity/productivitymeasures

by the ESRC and had two-phases (01/08/2019 - 31/03/2027). The programme had the following objectives:

- Drive a step-change improvement in the UK's productivity research and innovation.
- Improve and sustain the systematic generation and use of evidence to address the UK's productivity challenge.
- Develop practical interventions for improving productivity based on high-quality evidence.
- Involve all relevant stakeholders, especially those from unrepresented and underrepresented places, groups and sectors.
- Support the formation of a dynamic multidisciplinary community working together on research and practical interventions.
- Form enduring and sustainable structures to facilitate mutual engagement between researchers, policymakers and businesses.

D.8.3. Programme Design and Delivery

Design

The PIP comprised of three separate investment streams: The Productivity Institute (TPI), Programme on Innovation and Diffusion (POID) and a series of thematic investments.

1. ***The Productivity Institute (TPI)***

TPI is the largest component of the PIP, with an initial £32m investment, and is located at the Alliance Manchester Business School. It began in September 2020 and will continue until 31st March 2027) supported by the ESRC funding, with the view to continue beyond this through other funded projects and funders. It serves as a research hub to drive a better understanding of the UK's productivity, aligning directly with the UK government's Industrial Strategy, which emphasizes boosting productivity, innovation and regional growth.[80]

The Productivity Institute (TPI) has approved 14 new projects. This is based on a call for research proposals aimed at providing frameworks, solutions, or tools to address productivity at various levels within organizations. Additionally, the TPI has established 11 new university relationships and expanded strategic partnerships.

TPI engages with private and public sector stakeholders to build the UK's long-term research capacity through its Regional Productivity Forums (RPFs) and a Productivity Commission. The RPFs, run by TPI's academic partners, address a wide range of themes, while the Productivity Commission enables policy development at a national level. For instance, each forum worked directly with organisations to identify obstacles to productivity at the individual, firm, and institutional level, and to formulate and evaluate private and public policy actions.

TPI also collaborates with Be The Business, a business support charity, to engage with SMEs. TPI is jointly funded by the ESRC and the Alliance Manchester Business School.

[80] Industrial Strategy: https://assets.publishing.service.gov.uk/media/5a8224cbed915d74e3401f69/industrial-strategy-white-paper-web-ready-version.pdf

2. ***The Programme on Innovation and Diffusion (POID)***

POID, based at the London School of Economics (LSE), is funded by the ESRC with a total £5m investment, and focuses primarily on cutting-edge research to enable the diffusion of innovative ideas and technology across the UK's economy. POID works with stakeholders across academia, government and the private sector to understand and develop policy in line with diffusing innovation. Additionally, POID aims to create and facilitate accessibility to high-quality data to improve the UK's understanding of productivity, thereby strengthening the evidence base for businesses and policymakers. Themes covered by POID include industrial and innovation policy, wages and firms, healthcare and the economy, finance and innovation, power in the firm, green growth and directed technical change.

3. ***Thematic Investments***

PIP's thematic investments consisted of seven thematic research projects, commissioned between 2022 and 2023 with initial investments of approximately £2m in total, focusing on:

- Productivity, Wages and the Labour Market, led by the Institute for Fiscal Studies (IFS).
- Diversity and UK Firm Performance, led by University College London (UCL).
- Diversity and Productivity: from Education to Work (DaPEW), led by LSE.
- Constraints on access to finance and underinvestment impact on productivity growth in smaller firms, led by Oxford Brookes University.
- Servitisation's impact on UK economic productivity and environmental performance, led by Aston University.
- Productive and Inclusive Net Zero (PRINZ): opportunities and barriers in the transition to sustainable and equitable growth, led by Imperial College London.
- Mental health and well-being practices, outcomes and productivity: a causal analysis, led by the University of Warwick.

D.8.4. Intersectoral working and collaboration

Programme collaboration was felt to vary across the different thematic research projects, as outlined in the section above. These thematic projects are integrated to address different aspects of the productivity issue. TPI focuses on understanding productivity from the perspectives of people, firms, institutions, and the broader economic system. This involves examining factors like investment, technology diffusion, and the need for joined-up policies across different levels.

In essence, the TPI's thematic areas work together to:

- Identify the root causes of productivity stagnation in the UK.
- Develop evidence-based recommendations for boosting productivity growth.
- Promote the diffusion of best practices and technologies across different sectors and regions.
- Address the challenges of institutional fragmentation and promote joined-up policies.
- Engage with businesses and policymakers to translate research into real-world impact.

Engagement and involvement from the DWP in regular research events helped shape areas of the research agenda, such as workforce skills, public sector productivity, and the social

impact of economic growth. These events included conferences, seminars, bilateral meetings, content production, and panel discussions to foster collaboration and share insights on productivity-related topics. These events are often held as part of National Productivity Week, which features a diverse range of activities aimed at tackling the UK's productivity slowdown. For example, the National Productivity Week event hosted by the Kings College London Business School focuses on "The future of sustainable growth in the construction industry and on-street charging infrastructure".[81] These discussions were held with the purpose of creating a two-way dialogue between the DWP and Institute of Fiscal Studies (IFS), which in turn influenced the research scope of IFS's project, as well as leading to the creation of policy papers and direct research impacts such as IFS's work to show that health is not a direct cause of productivity decline in labour markets.

There were also some further examples of sharing opportunities and emerging evidence across different projects, facilitated through various interactions with some other thematic investments, POID and TPI, such as webinars and engagement events.

Finally, there were different challenges associated with engaging businesses. For example, different disciplines find it more or less difficult to engage with firms, with economists finding it the most difficult and those with business school backgrounds finding it less difficult. This can be attributed to differences in knowledge bases, skill sets and perspectives among disciplines. This suggests that there may be disciplinary barriers to effective engagement with businesses. Bringing in further expertise when engaging with businesses is strongly encouraged.

Multi- and inter-disciplinary approach

The programme supported a multi- and interdisciplinary approach from the start. This was due to the theme-led nature of the grant call when it was announced. The call required project partners to come from different sectors and disciplines. These partners were expected to work together to address the issues outlined in the call for proposals.

The programme brings in expertise from economics, engineering, and mathematics, particularly in areas like supply chain analysis. One example includes a collaboration with a health economist from Ireland and a Swedish research group for a business survey, providing valuable international perspectives and comparisons. However, it was felt that whilst there was a diversity of disciplines involved, the main body of researchers was across the engineering and economic disciplines. Participants noted that having common identified challenges to cross collaborate on helped foster interdisciplinary working and learnings. For instance, the Investment in Productive Places study for Rochdale assessed the different community capitals framework.[82] It brought together economists, wellbeing experts, and policy evaluators, through collaborative meetings. This approach helped foster knowledge exchange about the different disciplines and how they understood community capitals and measurement techniques.

[81] KCL Productivity Challenge: https://www.kcl.ac.uk/news/the-london-and-south-productivity-challenge

[82] Community Capitals Framework: https://www.productivity.ac.uk/research/framing-a-place-based-investment-strategy-for-rochdale/

Leadership management of TPI was subdivided across five different communities of leading experts, policymakers and practitioners. These leadership teams included the management team, the Executive Team, the Governing Council, the Advisory Committee, and the Productivity Commission. Collectively, these five leadership teams managed the programme at two levels: 1) to oversee the direction of the programme as well as the funding calls and 2) resource management of small research projects.

Given that PIP was a large-scale programme developing an institute, many participants interviewed commented on how it worked well to foster interdisciplinary working directed by a diverse community of leading experts, policymakers and practitioners. This was achieved through collaborative meetings across the executive team, advisory committee and governing council. This ensured emerging findings and activities occurring across the different forums were raised and discussed, particularly in terms of relevance to other forum activities.

Changing needs and opportunities

The challenges that the programme addresses are associated with the UK's ongoing and current productivity challenges at a regional level. During the duration of the programme, it adapted to and attempted to address the following three challenges:

- Underinvestment: TPI recognizes that many UK businesses are not investing enough in new technologies, skills, or infrastructure, which hinders their ability to become more productive. They investigate factors that discourage investment, such as economic uncertainty, short-termism, and lack of long-term vision.
- Inadequate Diffusion: TPI highlights the need for better diffusion of productivity-enhancing practices and technologies among UK firms. They study how firms adopt new technologies and best practices, and how policy can be designed to encourage broader adoption.
- Lack of Joined-Up Policymaking: TPI emphasizes the importance of aligning science, innovation, and growth policies to attract global knowledge-intensive companies and strengthen the diffusion of innovation. They advocate for more integrated policies that address the UK's productivity challenges in a comprehensive way.

In addition, the COVID-19 pandemic introduced significant challenges for government priorities. However, the use of online video platforms, such as Zoom and Microsoft Teams, were already within the programme's plans as it encouraged and fostered a shift toward net-zero emissions. In many cases, projects did not require major adjustments in response to the pandemic—either because they were launched after the peak of the crisis or had already secured robust industrial partnerships prior to their inception.

D.8.5. Programme outputs

In 2023/24, The Productivity Institute (TPI) saw the completion of its initial research projects across eight broad themes, with key insights contributing to the development of The Productivity Agenda, which has already informed regional and national policy discussions and guided interventions within partner organizations. The ongoing research programme, organized into seven distinct programmes under the pillars of People, Firms, and Institutions, included over 20 projects, several of which produced actionable recommendations that firms and local authorities have begun to adopt. As the year progressed, plans were made for a series of workshops leading to the International Productivity Conference in September 2025,

designed to translate research outputs into stakeholder engagement and practical guidance for businesses and policymakers. Additional funding was allocated for UK-based Research Fellowships to support the research team's work, enabling knowledge transfer and direct collaboration with industry and government partners.

TPI released The Productivity Agenda in November 2023, which was detailed into a series of policy briefs aimed at Westminster, devolved nations, and city governments, and some of these briefs were already used by local authorities and regional policymakers to inform decision-making on workforce development and productivity strategies. In May 2024, Professor Andy Westwood joined TPI's Management Team as Policy Director, with the establishment of a dedicated TPI Policy Unit launched in October 2024. This unit aimed to enhance the visibility of TPI's recommendations and ensure their adoption and practical implementation by government departments and regional authorities.

Throughout 2024, TPI also initiated calls for International Research Fellowships and Policy Fellowships, which facilitated direct engagement between researchers and policymakers, allowing findings to be applied in real-time to inform local economic development strategies. It continued its focus on business innovation and place-based productivity, holding active forums, offering executive education, and expanding international visibility through conferences and partnerships, all of which contributed to immediate changes in firm practices and policymaker awareness. Funders expressed a strong interest in sustaining these collaborative relationships, which were significantly strengthened through the SPF, leading to enhanced knowledge sharing and adoption of productivity-enhancing practices across participating organizations.

Following an Innovation Lab workshop held in early 2024, the Yorkshire, Humber, and North-East Forum undertook research to examine recruitment, training, and staff retention practices among firms in the region. The project aimed to identify the incentives and disincentives for employer training, understand the challenges of retaining skilled workers, and explore how training practices were linked to other HR practices and external support mechanisms. Early outcomes from this forum included participating firms implementing revised recruitment and retention policies based on these insights, and local training providers adapting their offerings to better meet business needs.

Meanwhile, the North-West Productivity Forum collaborated with the North-West Business Leadership Team (NWBLT) on a project focused on outlining actions to enhance productivity in the North-West by 2040. This project involved scenario planning and road mapping to identify key drivers of change and develop policy recommendations, some of which have already been adopted by regional economic development boards and incorporated into local strategic planning documents, demonstrating a clear pathway from research outputs to tangible regional impact.

D.8.6. Programme outcomes and impact - R&I to address priorities

The Productivity Institute conducted multiple projects to investigate and address the country's longstanding productivity challenges. It was created in response to the UK government's focus on economic growth, net zero, and better healthcare and was therefore well aligned with the UK's R&I priorities. It was noted that this was shaped not only by the government's involvement when setting the direction of the fund, but also their continued engagement with the programme itself, including the DWP.

Researchers, partners and funders felt that the outcomes of the programme had been taken up at a regional level. For instance:

- A pilot study investigated whether lighter-touch interventions could potentially encourage behaviour change through habit formation, highlighting a promising avenue for further research into how SMEs might respond to more time-intensive engagement strategies.
- One policy sector participant highlighted strong involvement from regional policymakers and local businesses, leading to programme outcomes that were shaped by local priorities and needs. This regional engagement was seen as key to the success of certain projects.

Nonetheless, the following challenges were identified:

- Despite successes at the regional level, one participant felt that greater influence was still needed at higher and national policy levels to meaningfully shape the wider productivity debate. They suggested that this could be achieved through increased access to national decision-makers, active participation in policy discussions, and more significant roles within leadership or steering committee meetings during the programme's design phases.
- Programmes of this kind typically require a substantial time commitment from SMEs, which may discourage participation.
- Further research is needed to explore how to position interventions that are lighter-touch than intensive in-person courses but more engaging than static online resources, to broaden accessibility and impact.

D.8.7. Programme outcomes and impact – ecosystem change

Multiple stakeholders and partners felt that it is too early to fully evaluate whether there has been ecosystem change resulting from the programme. According to one participant, an example of ecosystem change occurring during the programme was encouraging MIDRI working via the funding theme, as well as working towards addressing a common research challenge. The SPF helped unify a diverse group of experts from various fields and industries. This collaboration proved effective, fostering new connections, enhancing teamwork, and ensuring outcomes are thoroughly documented.[83]

Research institutions, partners and funders reported that the programme has supported intersectoral working by involving government partners (e.g., DWP). This was found particularly helpful at the onset of the programme. This approach was perceived as beneficial for partners, Research Councils and government organisations. Many reported positive outcomes resulting from intersectoral working and collaborations generated by the programme. For instance, two researchers went on to become special scientific advisers to the UK government and the National Institute was set up to oversee UK productivity. Furthermore, the POID provided evidence to the Treasury Committee on the regional economic impacts of coronavirus, an issue of national importance. POID's participation in the BEIS Green Jobs Taskforce Workshop212 and R&D Place Advisory Group meetings highlights their contributions to discussions on green jobs, and research and development, both crucial

[83] The Productivity Institute publications: https://www.productivity.ac.uk/research/?publications_type=reports

aspects of the national productivity agenda. This demonstrates alignment with national priorities for green growth and innovation diffusion, directly supporting Industrial Strategy objectives and the UK Net Zero Mission.[84]

Some barriers noted by researchers, policymakers and industries were related to ways of communicating and research priorities. For instance, understanding the different priorities of each sector that engaged in the programme proved challenging. For academics this was the quality of the research and publication outreach (e.g., number of citations, and wider impacts on their research fields). For policymakers this was translating research findings into practice. For example, innovation and productivity can be enhanced through local business knowledge exchange. This can be achieved by encouraging local businesses to share knowledge and best practices through established networks.

It was noted that research institutes and business partners built strong partnerships throughout the programme. However, a communication gap with senior policymakers was also identified. Reasons for this included time availability, and the need for greater involvement of national-level policy decision-makers in leadership and steering committee meetings.

It was felt, for instance, that while there was lots of dialogue between policymakers and researchers at regional levels, there was less at a national level. According to participants, this was due to the higher number of activities taking place at a regional level through forum and research initiatives rather than at a higher national level. With support from the SPF, a multidisciplinary team was assembled to understand and design a regional agenda to support UK productivity and growth. The funding enabled them to apply this shared knowledge across engineering, economics and statistical disciplines. For instance, the collaboration between economists and engineers created a better understanding of UK supply chains.

In terms of stakeholder engagement and research dissemination, instances where thematic investments, TPI (including regional forums), and POID have used each other's networks and communication platforms to share event details have been observed. For example, Aston have used RPF meetings to present on 'Servitisation: An Introduction and Opportunity', and have met with TPI to discuss business model innovation, manufacturing and productivity. Additionally, the University of Warwick's thematic investment has presented to the ESRC programme board at an ESRC Productivity Projects meeting in Manchester.

D.8.8. The Future

One of the main ongoing outcomes was that the fund brought together a community of researchers from different sectors which would not otherwise have been possible. As a result of bringing these different disciplines and skillsets together, the programme developed understandings that are key to an effective policy agenda. For instance, there is the need for an integrated agenda of pro-productivity policies, which may be referred to as "joining up". For some time now TPI has promoted the idea of policy coordination for pro-productivity policies at both the national and the regional level.

[84] Net Zero Strategy: https://www.gov.uk/government/publications/net-zero-strategy

In addition, it is expected by the researchers and funders, that research publications will continue to emerge, as well as other forms of knowledge exchange activities. The publications associated with PIP, on average, received six times the international average numbers of citations (normalised for year and field of publication). Similarly, over 20% of publications were in the top-most highly cited publications for their field of research. As PIP publications continue to emerge, greater research impact on policy is also expected to materialize in the future. Expected ongoing publications, podcasts, and blogs align with government R&I priorities for evidence-based policymaking and innovation diffusion under the UK Industrial Strategy.

Additionally, PIP researchers published podcasts as part of its Productivity Puzzles series, blogs on its website or those of PIP affiliated universities, and articles or blogs in external publications. These combined engagement efforts resulted in media coverage mainly from print/online publications, but with some TV and radio/podcast appearances as well.

Furthermore, the OECD Global Productivity Forum and a conference is expected to take place in September 2025. These activities provide an in-depth analysis of key areas of pro-productivity policies at the regional level. While productivity is inherently place-based and varies significantly across regions, three themes emerge as the foundational elements for a regional agenda on pro-productivity policies:

- Raising public and private investment.
- Strengthening the diffusion of productivity-enhancing practices between firms and places.
- Tackling institutional fragmentation and joining up policies at national and regional levels.

D.8.9. Summary and reflections

The Productivity Innovation Programme (PIP) comprised three streams: The Productivity Institute (TPI, £32m), the Programme on Innovation and Diffusion (POID, £5m), and seven thematic investments of approximately £2m. TPI, based at Alliance Manchester Business School, drives research on UK productivity and engages public and private stakeholders through Regional Productivity Forums (RPFs) and the Productivity Commission. POID, hosted at LSE, focuses on innovation diffusion, policy insights, and access to high-quality productivity data.

The programme involved academia, government departments such as DWP, and industry partners, with collaboration fostered through conferences, webinars, and National Productivity Week events. Cross-sector dialogue helped shape research agendas, policy papers, and regional initiatives.

PIP integrated expertise from economics, engineering, mathematics, wellbeing, and policy evaluation. Thematic projects and Investment in Productive Places studies encouraged knowledge exchange across disciplines and regions, including international collaborations.

TPI released The Productivity Agenda in 2023, providing policy briefs for national and regional governments. Over 20 projects were completed, and ongoing fellowships and workshops continue to support research dissemination. Regional engagement influenced SME behaviour, workforce practices, and local policymaking, while POID contributed insights to the Treasury and green jobs initiatives.

Research publications, podcasts, and international conferences will continue to influence policy, with a core focus on investment, the diffusion of best practices, and joined-up productivity policies at both regional and national levels. Overall, PIP has established a strong foundation for evidence-based policymaking, supporting long-term improvements in UK productivity across multiple sectors.

D.8.10. Stakeholders interviewed

Interviews for the final SPF evaluation were conducted in March and April 2025 with:

- Hollie Doell, Programme Lead (Programme Manager or similar), ESRC.
- Alexandra Lowe, IUK
- Dan Mawson, DWT
- Mike Daly, DWP
- Damien Smith, Programme Director, ESRC
- Professor Bart van Ark, University of Manchester

The case study also builds on desk research and 7 interviews with programme leads and wider stakeholders conducted for the Interim evaluation report produced in 2022.

D.9. Space Weather, Innovation, Measurement, Modelling and Risk (SWIMMR) programme

SPF Wave 2	**SPF funding amount**: **£20 million**	**Programme Start and end date** **April 2019-March 2024**
Lead Council / PSRE: STFC	**Other Council / PSRE**: NERC	**Government departments/bodies**: DESNZ, DSTL and DfT
Other partners • Met Office		
Key objectives: The SWIMMR project aimed at developing appropriate space weather monitoring and forecasting tools, to enhance UK's capabilities in this field and avoid adverse consequences of space weather events on economic and societal activities. SWIMMR aimed to achieve the following objectives: • Objective 1: Mitigate the potential radiation hazards of space weather to satellites and aviation operations • Objective 2: Mitigate potential space weather effects on communication and global positioning • Objective 3: Mitigate the potential risks of space weather to electric power distribution In addition, the project had the overarching objectives to establish a world-leading UK system for space weather modelling and forecasting, to develop a framework for transitioning models and data sets from the academic community to operational use at the Met Office, to produce an updated space weather impact assessment study, building on the Royal Academy of Engineering report of 2013; and thus to position the UK as a global leader in monitoring and mitigating the effects of space weather.		

D.9.1. Summary

Introduction

The Strategic Priorities Fund (SPF) was an £831m UK Research and Innovation (UKRI) investment in multi- and Interdisciplinary research (MIDRI) across 34 themes announced in the Industrial Strategy White paper 2017,[85] to address gaps in research and innovation funding, evidenced in the Nurse review 2014.[86] The Space Weather Instrumentation, Measurement, Modelling and Risk (SWIMMR) initiative is a significant, four-year programme backed by a £20 million

[85] https://assets.publishing.service.gov.uk/media/5a8224cbed915d74e3401f69/industrial-strategy-white-paper-web-ready-version.pdf

[86] https://assets.publishing.service.gov.uk/media/5a801c6fe5274a2e87db7eaa/BIS-15-625-ensuring-a-successful-UK-research-endeavour.pdf

investment included among the SPF funded projects. The programme was originally planned to run from April 2019 to March 2023 but got extended until March 2024, with some elements continuing to March 2025. In addition, the SWIMMR project was conceived in response to the UK Severe Space Weather Preparedness Strategy published by the Johnson Conservative government 2019-2022, that set out a 5-year vision for boosting UK resilience to the risk of severe space weather events. [87] The subsequent Labour government further reinforced the strategic role of space in several domains, including civil and defence. Changes in the governance of space affairs are also expected to occur in April 2026 (after the time of writing), when the UK Space Agency (UKSA) will merge with DSIT, hence space weather is expected to remain aligned with future policy priorities.[88]

At its core, the project is designed to substantially enhance the UK's capability for monitoring and forecasting the risks associated with space weather events. A primary driver for SWIMMR has been the UK's increasing dependence on advanced technologies that are vulnerable to the effects of space weather. This includes reliance on space-based assets for communication, navigation, timing and the possibility to monitor and predict space weather events, without the need to rely on equivalent tools developed in the United States.

The programme placed a strong emphasis on several key areas of space weather phenomena that pose a direct threat to the nation's infrastructure. These included:

- The impact of space radiation on aviation and satellite systems,
- Disruptions to communication networks caused by changes in the upper atmosphere,
- The potential for powerful electrical surges in national power grids and other ground-based systems.

As such SWIMMR aimed to achieve three main high-level objectives:

1. Mitigate the potential radiation hazards of space weather to satellites and aviation operations, by constructing miniature radiation monitors to use in satellites.
2. Limit potential space weather adverse effects on communication and global positioning, by improving the modelling of the ionospheric effects on radio communications.
3. Reduce the potential risks of space weather to electric power distribution, with updated and improved set of products and services for forecasting the impact of Geomagnetically Induced Currents on power grids.

Stakeholders' interviews provide evidence of progress against all objectives, and the forecasting tools are now in use by the Met Office.

The SWIMMR programme has been a collaborative effort involving several key UK agencies and Government departments. The project was led by the Science and Technology Facilities Council (STFC) in partnership with the Natural Environment Research Council (NERC). Despite some overlapping competencies, these agencies did not cooperate extensively in the past on

[87] https://www.gov.uk/government/publications/uk-severe-space-weather-preparedness-strategy.

[88] The most recent reference to a future space policy appears in the recent UK Space Agency Corporate Plan, 2025-2026.

space weather, meaning SWIMMR represented an opportunity to enhance collaboration. The programme received support from and has been developed in close association with:

- The Met Office Space Weather Operations Centre (MOSWOC), which is the primary end-user of the models and instruments developed.
- The Department for Business, Energy and Industrial Strategy (BEIS) and latterly the Department for Energy Security and Net Zero (DESNZ).
- The Department for Transport.
- The Defence Science and Technology Laboratory (DSTL-Ministry of Defence).

D.9.2. Programme design and delivery

Intersectoral work and collaboration

The implementation of SWIMMR represented an intersectoral effort, involving a group of partners from two different UK research councils and three government departments. Interviewees agreed that this project was an example of successful collaboration, bringing together research and political entities that had not previously collaborated.

Structure and mechanisms of intersectoral collaboration

In terms of formal organisational governance, the project was directed by the following bodies:

- **Programme Board:** This group was chaired by STFC and attended by representatives all the main stakeholders, including both Research Councils, the Met Office and government departments. Meeting monthly, the Programme Board was the main mechanism for regulating the detailed direction of the project.
- **Strategic Advisory Group:** This was a group of more independent experts, including representatives of potential end users, such as satellite operators and the National Grid. Meeting quarterly, its primary function was to discuss potential challenges, ensure that the programme aligned to user needs and draw attention to external developments that might require a change in direction.
- **Governing Board**: This was a combination of the Programme Board and Strategic Advisory Group, which met twice a year. Chaired by BEIS/DESNZ it was the ultimate authority for the project and the only group with the power to stop projects, or commission new ones.

The SWIMMR project also operated in a wider landscape of national and international collaboration:

- **Government working groups:** Beyond its own governance, the programme leadership reported directly to established government oversight bodies. An interviewee described reporting progresses of the SWIMMR project to the Severe Space Weather Working Group ran by DESNZ (BEIS at the time). This provided a direct channel to ensure the programme remained aligned with cross-government priorities.
- **The annual symposium:** This event, mentioned by all interviewees, became a crucial mechanism for bringing multiple institutions operating in the space weather sector together and to showcase the progresses achieved by the SWIMMR programme. One interviewee explained how it evolved from an internal progress meeting to a major annual conference

called "UK Space Weather and Space Environment Meeting".89 The first annual conference took place during the COVID-19 pandemic and there were 50-60 attendees. Attendance grew over time and in 2024, over 200 people took part of the conference. This created a shared space for academics, operational forecasters, and policymakers to interact with an international reach; in 2024, 25% of the attendees were from overseas, including officers from NASA.

All interviewees agreed that the governance structure described above, ensured a good level of collaboration among the different project partners and no issues were highlighted regarding its appropriateness and functioning.

Extent of previous collaboration

The consensus from the interviews is that this level and style of collaboration was new and that the partners had previously worked in a much more fragmented and siloed manner.

- Collaboration between councils: The separation between STFC and NERC research remits was a significant barrier that SWIMMR overcame. The pre-SPF working pattern did not involve these two councils sharing research activities especially in the domain of space weather. However, the multi – and inter disciplinary nature of SWIMMR fostered collaboration.
- Collaboration between Government and councils: The connection between government departments and the wider research community was traditionally very weak. One representative from the Government described the level of "understanding and integration" between government departments and research councils as "very low".

New ways of working and collaborating between partners in governance, management and delivery

Evidence from the interviews suggested that the programme favoured enhanced ways of working among partners that influenced positively the management and delivery of SWIMMR. However, the onset of the COVID-19 pandemic at the same time as the programme launch, was also a factor that contributed to finding alternative ways to cooperate. Hence, interviewees did not think that SWIMMR was the unique reason behind new ways of collaborating amongst stakeholders.

Multi- and inter- disciplinary (MIDRI) approach

With respect to the extent to which the SWIMMR project led to a multi and interdisciplinary approach, interviews confirm that the project was "interdisciplinary by design" and this has been one of the reasons behind the programme's success. A key feature of the programme was bringing together disciplines and communities that had previously operated in separate spheres or "silos."

- ·Enhanced council collaboration: One of the most relevant achievements of the programme was to enhance collaboration between two lead research councils, STFC and NERC. Their remits naturally divide the domain of space weather, which had historically created a barrier to collaborative research. An interviewee explained this fundamental

89 https://www.iop.org/events/uk-space-weather-and-space-environment-meeting-ii

split: "Things that are solar wind related or related to the outer magnetosphere, for example, those really are in the STFC funding domain. Things related to nearer Earth so, earth directed space weather, is in the NERC remit". This pre-existing differentiation, which resulted in the absence of a lead council responsible for space weather events, prevented research progress in this area. One respondent noted that "neither one of them would hold their hand up and say, yes, we're responsible for space weather." Another interviewee confirmed this historical separation, noting that prior to SPF, the "silo approach was more common." SWIMMR, enabled by the SPF, encouraged these two councils into a close working partnership, removing what was called "domain anxiety" for researchers.

- Uniting science with engineering: The programme was instrumental in closing the gap between the pure science community and the applied engineering and operational communities. One interviewee noted that before SWIMMR, there was "quite a split in the space weather community between people who were on the science side and people who were more on the engineering and application side. And those people often did not appear at the same meetings together". The new collaboration emerged from SWIMMR, a consultee stated: "I think we brought... Space weather science closer to software engineers, which I think is going to be a big benefit to the UK going forward." This was driven by the operational need for robust, reliable operational tools, a very different requirement from standard academic research.
- Connecting research with Government: The programme fostered a much closer relationship between the academic research community and government departments with operational needs. One representative of a government department admitted not knowing about STFC role and RAL Space[90] (RAL Space is the UK national laboratory conducting research on space and environment): "I don't think we would have even known that STFC and RAL Space existed". Another consultee informed that SWIMMR helped to develop a deeper understanding of the work conducted by STFC and how its applications have important repercussions in several domains including transport, communications and defence.

Mechanisms to encourage MIDRI proposals

There were multiple programme mechanisms to encourage MIDRI proposals, including:

- Interdisciplinary design: The most powerful mechanism was the nature of the programme itself. It was conceived as a solution to a complex, multifaceted problem that inherently required an interdisciplinary approach. One interviewee commented: "We didn't do MIDRI because we had SPF. We did SPF because our idea was inherently MIDRI." This means that rather than trying to bolt on an interdisciplinary component to existing research calls, the entire programme was built on a MIDRI foundation from the outset.
- Demonstrating commitment: The existence of a large, strategically funded programme like SWIMMR sent a powerful signal to the research community. A consultee explained that the programme "demonstrated to the community that there is genuine support for MIDRI proposals and that the councils and UKRI are committed to finding better ways to support

[90] RAL Space About RAL Space, https://www.ralspace.stfc.ac.uk/Pages/About-RAL-Space.aspx

MIDRI." This visible commitment and recognition of the value of MIDRI was a significant encouragement to pursue this way of conducting research.

- Significant funding: There was also a practical element to the support. All interviewees noted that the programme was able to provide adequate resources for interdisciplinary work, including "allowing MIDRI based research activity a little bit more time in order to establish all of the good working practises that MIDRI researchers needed." Therefore, standard funding allocated to non MIDRI research would have not been able to achieve the results obtained by the SWIMMR programme.

New or enhanced mechanisms to assess MIDRI proposals

The key themes that emerged with respect to any new or enhanced ways to assess MIDRI proposals are detailed below:

- Cross-council representation on assessment panels: The most distinct new mechanism was the inclusion of members from the partner research council on assessment panels. An interviewee described this innovation: "one thing we did do is we had a cross person from the other Research Council on all of the assessments. So, there was always an STFC person in the NERC panels and a NERC person in the STFC panels, which is not something that is normally done". This ensured that proposals were viewed from both disciplinary perspectives and that the interdisciplinary value was properly understood and evaluated.
- Ensuring MIDRI expertise: This approach was reinforced by a commitment to having the right expertise on the panels. One consultee confirmed this, stating that "if MIDRI is a significant element of the competition call, then we ensure that MDRI expertise is on the panel". This shows a deliberate effort to move beyond traditional, single-discipline assessment criteria and to judge the proposals on their interdisciplinary merits.

Quality of MIDRI proposals

The evidence from the interviews suggests that overall, the programme was successful in attracting high-quality proposals, largely because of its strategic and well-defined nature. The programme's clear, needs-driven calls encouraged the best researchers in the field to collaborate and submit strong, unified bids. One interviewee, who was more cautious about attributing a change in quality of MIDRI proposals on the programme over time, still positively confirmed that SWIMMR successfully communicated the need for research excellence: "*It [the programme] has placed a greater emphasis on the need for high quality MIDRI proposals*." This implies that the programme effectively set a high bar for the community to meet.

Response from the research community

The interview findings portray a research community that was very responsive to the programme's calls, often proactively organizing to meet the specific, interdisciplinary challenges set out by SWIMMR. The UK space weather community responded with enthusiasm and a high degree of coordination, forming consortia to deliver the programme's strategic objectives. One interviewee described the creation of consortia to provide high quality bids. This implied that research organisations, responded with a coordinated and collective efforts to respond to these calls at best.

Extent to which the MIDRI nature has allowed to address more complex and multi-faceted priorities

There is strong consensus that the programme's inherent MIDRI nature was the essential characteristic that enabled it to tackle the complex, cross-domain challenge of space weather. By breaking down institutional and disciplinary silos, SWIMMR was able to address the space weather problem effectively, supporting the transition from pure science to operational application—in a way that a single-discipline or single-institution approach would have struggled. One stakeholder provided a practical example of how this worked, describing SWIMMR as very much run as an interconnected programme where *"an output from one project is an input to another part of SWIMMR*". This interconnectedness was vital for modelling the entire chain of events in a space weather storm, a truly multi-faceted challenge.

Finally, the evidence from the interviews strongly indicates that the programme did not undergo major shifts in its high-level strategic priorities. The core mission remained consistent, though minor tactical adjustments were made in response to scientific realities. The programme's primary aim—to transition research models and tools into operational use at the Met Office—was established at the outset and remained the central focus throughout.

D.9.3. Programme outputs

The SWIMMR programme was tasked to deliver several monitoring and supporting tools to forecast space weather events. The £20m budget was spread across 11 projects, split between NERC (£9.8 million) and STFC (£10.2). The following table summarises each output associated with the different strands of work and their current status.

Table 6 SWIMMR projects split between STFC and NERC

NERC projects	Status	STFC projects	Status
1. Improvement of satellite risk forecasts	Delivered	1. In-situ radiation measurements for space and aviation	Delivered
2. Improvement of aviation risk forecasts	Delivered	2. Support for technology testing and modelling	Delivered
3. Improved forecasting for GNSS and HF communications	Delivered	3. Support for the transition from research to operations	Delivered
4. Improved forecasting of ground level current effects	Delivered	4. Forecasting from the Sun to L1	Mostly delivered but some outstanding tasks ongoing
5. Improved forecasts of satellite drag	Delivered	5. Support for a ground radiation monitoring network	Delivered but with some changes of the original design
		6. Space Weather Impact study	Delivered

Source: Presentation "From Innovation to impact: Lesson from SWIMMR", STFC

There is a strong consensus among consultees that the SWIMMR programme delivered on all objectives set at the start. All 11 monitoring and forecasting tools have been handed over to the Met Office; these will need an additional two to three years to become fully operational. Dissemination of outputs occurred through the following channels:

- Programme board updates: During the monthly catch-up meetings, NERC and STFC were able to update all stakeholders involved (i.e. both government and research agencies) about the progress of all strands of work.
- SWIMMR symposium: The SWIMMR Symposium held annually since 2021, has provided a chance to showcase the progress made to all the stakeholders involved. Overtime, attendance increased, and it turned into an international event on the Space Weather science. It has now been renamed UK Space Weather and Space Environment Meeting.[91]

Overall, the SWIMMR programme has been disseminated through effective channels and Government departments as well as the Met Office have engaged significantly with the programme. Referring to some post SWIMMR follow-up activities, a representative from one of the departments said: "*We are already, technically, funding the aviation monitors to fly after the program's finished, so we'll be putting our own money into continued use of the programme*", another stakeholder affirmed: "*We are in the position where all the models have been provided to the Met Office and are (almost all) operational, there are tangible capabilities working now that were not there before. Considerable achievements have been delivered*".

D.9.4. Programme outcomes and impact – R&I to address priorities

Extent to which the outputs have been take up by end users

The research and innovation outputs from the SWIMMR programme have been taken up by the Met Office and are actively being implemented to address the existing gap in the UK's space weather forecasting capability. The programme successfully delivered all planned models and tools to the Met Office, which is now undertaking a multi-year project to integrate them into its operational services. One of the stakeholders confirmed the outputs were of high quality and relevance, stating, "*that was the whole point… we've always been thinking about the end user services we'll be delivering at the end of this*". Concrete examples include a new model to forecast Geomagnetically Induced Currents, which directly addresses risks to the national grid (and particularly relevant for DESNZ), and enhanced radiation models that are critical for aviation safety. The impact of this contribution is a significant enhancement of the UK's sovereign capability, reducing reliance on US assets in the field of space weather. The director of the National Ocean and Atmospheric Administration (NOAA) Space Weather Prediction Centre in the USA, also stated that "*SWIMMR has set a new global standard for how research should be done to support operations*".

Key lessons learned and challenges

Based on the insights from the stakeholders, several key lessons were learned from the delivery of the SWIMMR programme.

- Multidisciplinary work: In terms of intersectoral working, the programme was highly successful in bridging the gap between academia, operational agencies, and government policy departments, creating a more "seamless" community where one previously did not exist.

[91] https://iop.eventsair.com/ukswse2024/

- Operational agency: A significant lesson was the value of having an operational body like the Met Office act as an "efficient interpreter" between the often-divergent worlds of research and policy. However, a challenge encountered was underestimating the time required to establish a "common understanding" between different disciplines and sectors at the outset.

While the evidence suggests that the delivery and outputs of the SWIMMR programme were positive overall, a challenge was reported by two stakeholders. This is referred to the space weather impact report written by STFC. This work was aimed at providing a series of recommendations to the UK Government, but it has not been endorsed by the Space Environment Impacts Experts Group (SEIEG).[92] This meant that other government departments cannot base their future space weather strategy on the conclusions reached in this document, with potential repercussions on future funding and policies in this field. One interviewee, for example, stated that *"this is problematic for us because we were planning to hang a lot of strategy on that."*

Extent to which SWIMMR supported MIDRI research

Regarding the support for multi and interdisciplinary research, the primary lesson was the critical role of the SPF itself. The fund provided a mechanism to overcome the pre-existing siloed approach enabling STFC and NERC to collaborate effectively on space weather research. One interviewee stated *"without the SPF it would not have happened. Very simple."* While this demonstrated a successful model, a challenge remains in the sustainability of this approach, with concerns that the ecosystem could revert to its previous state without similar future funding mechanisms. One consultee stated: "*I would love SPF to be something we do permanently, but because we're not doing it permanently, the ecosystem will go back to the way it was*". The main concern was especially around funding that in non-MIDRI research work is not considered sufficient to deliver a programme like SWIMMR. However, some interviewees highlighted that events like the Symposium, will probably remain in future: "*The symposium, for instance, will hopefully be a permanent thing which will help the community work together*".

Finally, in helping to address government R&I priorities, a clear lesson was the effectiveness of a large-scale, strategically directed programme with an identified end-user. The SWIMMR model allowed for a coordinated approach to alleviate a complex national risk that individual departments could not tackle alone; as one Government stakeholder noted, *"we couldn't have done one of those sub programmes... on our own"*. The programme's success was underpinned by its ability to translate government needs into a coherent set of research and operational deliverables, a process that is otherwise considered *"haphazard"* and a *"complete dice roll"* when relying on standard responsive-mode funding.

[92] The Space Environment Impacts Expert Group (SEIEG) is an independent committee of experts drawn from Academia, Research Institutes, Companies, and Agencies. The primary purpose of SEIEG is to assess the science related to space weather, review the impact to people and modern infrastructure, and to provide support and advice to the UK Met Office and Government Departments.

D.9.5. Programme outcomes and impact – ecosystem change

Understanding of government priorities

Based on the evidence from the interviews, the SWIMMR programme has significantly enhanced the mutual understanding between government and the research community. The academic community now has a much clearer appreciation of government priorities, a shift facilitated by the programme's structure which encouraged direct dialogue. As one of the consultees noted, this was a two-way process where "*we actually have policy teams stood up in front of scientists explaining what they're looking for*". Reciprocally, government departments have gained a more nuanced view of the scientific process. Stakeholders reported that UK Government policymakers "*have a better understanding of the challenges that are faced in science.*" This improved insight helps manage expectations and fosters more effective collaboration on complex, long-term risks.

While the programme delivered successfully on its objectives, some interviewees have reported some concern about the absence of similar funding mechanisms that replicate the SPF approach. Project partners have all commented on the need for an SPF mechanism to be continued in the future.

D.9.6. The future

In terms of future activities, stakeholders have reported on further planned activities and have significant expectations for future outputs that build directly on the legacy of the SWIMMR programme. There is a strong consensus that while SWIMMR has concluded, its work has catalysed a new phase of development. A number of immediate activities are already underway.

One of the government departments for instance, has committed its own resources to the programme's legacy, confirming that "*we're already funding the aviation monitors to fly after the program's finished*".

Furthermore, the Met Office has initiated discussion with DSIT to secure follow-on funding to continue the work. The most significant expectation for the future highlighted by the Met Office, is to evolve from forecasting the space weather environment to increasing the precision of the predictions, by, for example, understanding if satellites and other relevant equipment will be damaged by certain space weather conditions.

D.9.7. Summary and reflections

The SWIMMR programme was a key initiative funded under the SPF, aimed at developing appropriate space weather monitoring and forecasting tools, to enhance UK's capabilities in this field. It has been delivered following an interdisciplinary approach (MIDRI) and the key outcomes are described overleaf.

While the SWIMMR project positively fostered collaboration among different partners (i.e. two research councils and three government departments), it was not deemed to be the sole factor to instate new ways of working collaboratively. The onset of Covid-19 at the same time as the start of the project, was also a key reason influencing new methods of collaboration amongst project partners. In addition, the programme successfully enabled cooperation between NERC and STFC research councils, who used to work in silos prior to SWIMMR on space weather research.

A central element of the programme was its multi- and interdisciplinary design. This overall MIDRI approach was supported by several key mechanisms to encourage MIDRI proposals, including a) a significant funding stream, b) the provision of adequate resources and time for collaborative practices to mature. Additionally, the programme was successful in attracting high-quality proposals, largely because of its strategic and well-defined nature. The programme also introduced new or enhanced mechanisms to assess MIDRI proposals, most notably the inclusion of cross-council representation on assessment panels, a practice not undertaken for other past funded competitions.

The extent to which the MIDRI approach allowed the programme to address more complex priorities was significant. Based on the evidence from the interviews, the SWIMMR programme has enhanced the mutual understanding between government and the research community, who worked together to address a well-defined priority by developing space weather forecasting tools.

A primary indicator of the programme's success is the extent to which its outputs have been taken up by end users. All 11 planned monitoring and forecasting tools were delivered to the Met Office for integration into its operational services. This delivery constitutes a tangible enhancement of the UK's sovereign capability in space weather forecasting, reducing reliance on international partners.

Despite these positive outcomes, the programme faced challenges that warrant consideration. One issue was the failure of the STFC-authored "Space Weather Impact study" to gain endorsement from the Space Environment Impacts Experts Group (SEIEG). This was reported as "problematic" as it created a policy gap for government departments that had intended to base future strategy on its findings. A more fundamental challenge relates to the sustainability of the collaborative model. Stakeholders expressed concern that the progress was intrinsically linked to the specific SPF funding mechanism, with fears that the research "ecosystem will go back to the way it was" in its absence.

In summary, SWIMMR serves as a successful example of a research programme that delivered on its objectives and impacted the research community. However, its legacy also highlights the critical dependence on specific funding models to enable such interdisciplinary work and the potential fragility of these achievements without a sustained, long-term commitment.

D.9.8. Stakeholders interviewed

The participants interviewed for the final SPF evaluation in May 2025 are:

- Kay Heuser, NERC
- Natasha Soutar, NERC
- Phil Messenger, Met Office
- Michael Lis, Met Office
- Ajinkya Rao, EPSRC
- Ellen Potts, ESRC
- Kevin O'Malley, IUK
- Tom Gardiner, NPL
- Stephen Holgate, University of Southampton

- Gary Fuller, Imperial College London
- Charlotte Hall, DHSC

The case study also builds on desk research and 7 interviews with programme leads and wider stakeholders conducted for the Interim evaluation report produced in 2022.

Appendix E Evaluation Questions

The following two tables present the 6 main evaluation questions and 29 sub-questions that the study should address. These were developed for the study by UKRI, with the SPF objectives and long-term impacts in mind.

Table 7 Evaluation questions

Questions	Sub-questions
1. To what extent, and how, is the SPF **working and being delivered as intended**?	1.1. What, in practice, is felt to be working more or less well regarding the **delivery of the Fund** (or programmes) by UKRI and the SPF Oversight Board, and why? 1.2. In allocating SPF funding to specific programmes, how did UKRI **use/interpret the overarching objectives** of the SPF to identify which programmes were of the highest priority? Was this approach to funding research and innovation a success in terms of maximising the fund's impact? 1.3. (To what extent) did the allocation of funding between Waves 1 and 2, and the **timing**, affect the ability to deliver the best quantity and quality of programmes for the SPF portfolio? 1.4. What is the range of **reported experiences** of researchers, innovators and other delivery partners in delivering SPF-funded programmes and projects? 1.5. What were the **challenges, facilitators and barriers** to implementing and delivering the SPF and its component programmes, if any? 1.6. What potential **lessons** are there for future waves / similar funds?
2. To what extent (and how) has the SPF supported an **increase in high quality MIDRI**?	2.1. To what extent, and how, has the SPF increased the efficacy of the funding system and the effectiveness of the peer-review process to **better assess MIDRI bids**? 2.2. To what extent, and how, has the SPF **de-risked the process** of preparing and submitting MIDRI proposals for the research and innovation community? 2.3. To what extent, and how, has the SPF encouraged **further MIDRI projects and programmes**, and a shift in research institutions towards this type of activity?
3. To what extent, and how, has the SPF improved the link between UKRI's investments and cross-departmental research and innovation priorities and opportunities?	3.1. To what extent, and how, has the SPF improved join up across Departments to establish **consensus on key Government priorities** for R&D? 3.2. To what extent, and how, has the SPF increased **understanding of Government priorities** among research and innovation funders? 3.3. To what extent, and how, has the SPF increased investments in **projects which further the objectives of government departments** and facilitated more effective alignment between R&D strategies? 3.4. To what extent, and how, has the SPF improved the ability of the R&D funding system to deliver cross-Government R&D priorities through **enabling PSREs to bid** for open competitions funded through the SPF?
4. To what extent, and how, has the SPF ensured that the research and innovation system is **able to respond to strategic priorities and opportunities**?	4.1. To what extent, and how, has the SPF increased high-quality **R&D in areas where gaps currently exist**? 4.2. To what extent, and how, has the SPF increased engagement with research and innovation communities to **identify emerging priorities**, and provided a sufficient investment to **address these opportunities**? 4.3. To what extent, and how, has the SPF improved: (i) the funding route for high quality **medium scale programmes**? and (ii) the agility of the funding system to **respond to emerging opportunities**?

Questions	Sub-questions	
5. To what extent, and how, has the SPF delivered **economic, knowledge and societal impact**?	5.1. What has been the wider, overall **economic impact** of the SPF, including the economic value of non-market impacts?	5.1.1. To what extent, and how, has the SPF succeeded in increasing **long-term investment in research and development**, including the leveraging of third-party investment? How much has materialised? If not, why not? 5.1.2. To what extent, and how, have SPF programmes resulted in the creation of **high skilled jobs, improved skills**, or increased the overall number of jobs? 5.1.3. To what extent, and how, has the SPF driven improvements in **business performance**, turnover and productivity?
	5.2. What has been the wider, overall impact of the SPF on **the state of knowledge**, both in the UK and internationally?	5.2.1. To what extent has the SPF driven the creation of **new knowledge**, such as new research publications, Intellectual Property (IP), Technology-Readiness-Level (TRL) and Manufacturing-Readiness-Level (MRL) advancement, process and conceptual innovation, etc.? 5.2.2. What specific **disciplines have collaborated** through, or as a result of, the SPF, and to what end? What does this imply about the extent to which the SPF has supported or enabled high-quality MIDRI? 5.2.3. To what extent has the SPF fostered **new approaches to collaboration** across the UKRI Research Councils, Other Government Departments (OGDs) and PSREs?
	5.3. What has been the wider, overall **societal impact** of the SPF?	5.3.1. To what extent, and how, has the SPF **impacted the environment, public health and wellbeing?** 5.3.2. To what extent (and how) have SPF programmes fostered more equal, diverse and inclusive research environments?
6. Based on the overall, estimated impact of the SPF – considering those impacts which can be given market and nonmarket values – compared to the overall cost of delivering the SPF, to what extent does the SPF represent **value for money**?	6.1. To what extent does the SPF and its programmes represent value for money given overall impact on knowledge, economy and society **relative to the size of the investment**? 6.2. To what extent does the SPF represent value for money **compared to other possible alternative ways** of achieving the same impacts?	

Appendix F List of Acronyms and Abbreviations

ACE	Adverse Childhood Experience
AHRC	Arts and Humanities Research Council
AI	Artificial Intelligence
AMHDM	Adolescence, Mental Health and the Developing Mind (programme)
BBSRC	Biotechnology and Biological Sciences Research Council
BEIS	(Department for) Business, Energy and Industrial Strategy
BPD	Bacterial Plant Diseases (programme)
BRIGIT	Surveillance and Response Capacity for *Xylella fastidiosa*
CMO	Chief Medical Officer (DHSC)
CRANE	Cyber Security Research and Networking Environment
CyberASAP	Cyber Security Academic Startup Accelerator Programme
DaPEW	Diversity and Productivity: from Education to Work
DBT	Department for Business and Trade
DCMS	Department for Digital, Culture, Media and Sports
DEFRA	Department for Environment, Food and Rural Affairs
DESNZ	Department for Energy Security and Net Zero
DfE	Department for Education
DfT	Department for Transport
DHSC	Department of Health and Social Care
DSIT	Department for Science, Innovation and Technology
DSQTA	Disseminated Secure QuanTime Autonomy
DSTL	Defence Science and Technology Laboratory
DWP	Department for Work and Pensions
EMBL-EBI	European Molecular Biology Laboratory's European Bioinformatics Institute
EPAC	Extreme Photonics Application Centre
EPP	Employer Pays Principle
ESRC	Economic and Social Research Council
EPSRC	Engineering and Physical Sciences Research Council
EU	European Union
ExCALIBUR	Harnessing Exascale Computing
FCA	Financial Conduct Authority
FCDO	Foreign, Commonwealth and Development Office
FSA	Food Standards Agency
GCHQ	Government Communications Headquarters
GFS	Global Food Security (programme)
GNSS	Global Navigation Satellite Systems
GO-Science	Government Office for Science
GPS	Global Positioning Systems
GtR	Gateway to Research
HMT	His Majesty's Treasury
IFS	Institute for Fiscal Studies

IFTS	Time, Frequency and Synchronisation
IoT	Internet of Things
IoTUK	Internet of Things UK
IOM	International Organisation for Migration
JCHR	Human Rights Joint Committee
LSE	London School of Economics and Political Science
MIDRI	Multi- and Inter-Disciplinary Research and Innovation
MHCLG	Ministry of Housing, Communities and Local Government (now part of DLUHC)
MoD	Ministry of Defence
MoJ	Ministry of Justice
MOSWOC	Met Office Space Weather Operations Centre
MRC	Medical Research Council
MSPEC	Modern Slavery and Human Rights Policy and Evidence Centre
NATA	Nucleic Acid Therapy Accelerator
NCE	National Centre of Excellence
NCSC	National Cyber Security Centre
NERC	Natural Environment Research Council
NGO	Non-Governmental Organisation
NIHR	National Institute for Health and Care Research
NPL	National Physical Laboratory
NPIF	National Productivity Investment Fund
NTC	National Timing Centre
NTOL	NPL Time Over eLoran
NWBLT	North-West Business Leadership Team
OECD	Organisation for Economic Co-operation and Development
OEP	Office for Environmental Protection
OGD	Other Government Department
Ofcom	Office of Communications
ONS	Office for National Statistics
PCF	Project Completion Form
PETRAS	Privacy, Ethics, Trust, Reliability, Acceptability and Security
PIP	Productivity Institute Programme
PNT	Position, Navigation and Timing
POID	Programme on Innovation and Diffusion
PPIE	Patient and Public Involvement and Engagement
PPS	Pulse Per Second
PRINZ	Productive and Inclusive Net Zero
PSRE	Public Sector Research Establishment
PWLE	People with Lived Experience
QSFP	Quantum Sensors for Fundamental Physics
RAKE	Rapid Automatic Keyword Extraction
R&D	Research and Development
R&I	Research and Innovation

RPF	Regional Productivity Forums
RSAB	Research and Stakeholder Advisory Board
SASA	Science and Advice for Scottish Agriculture
SATM	School of Aerospace Transport and Manufacturing
SDTaP	Ensuring the Security of Digital Technologies at the Periphery (programme)
SEIEG	Space Environment Impacts Experts Group
SMB	Senior Management Board
SME	Small and Medium-sized Enterprise
SPF	Strategic Priorities Fund
STFC	Science and Technology Facilities Council
SWIMMR	Space Weather, Innovation, Measurement, Modelling and Risk (programme)
TFS	Time, Frequency and Synchronisation
ToC	Theory of Change
TPI	The Productivity Institute
UCL	University College London
UKRI	UK Research and Innovation
UKSA	UK Space Agency
VeTSpec	Verified Trustworthy Software Specification

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